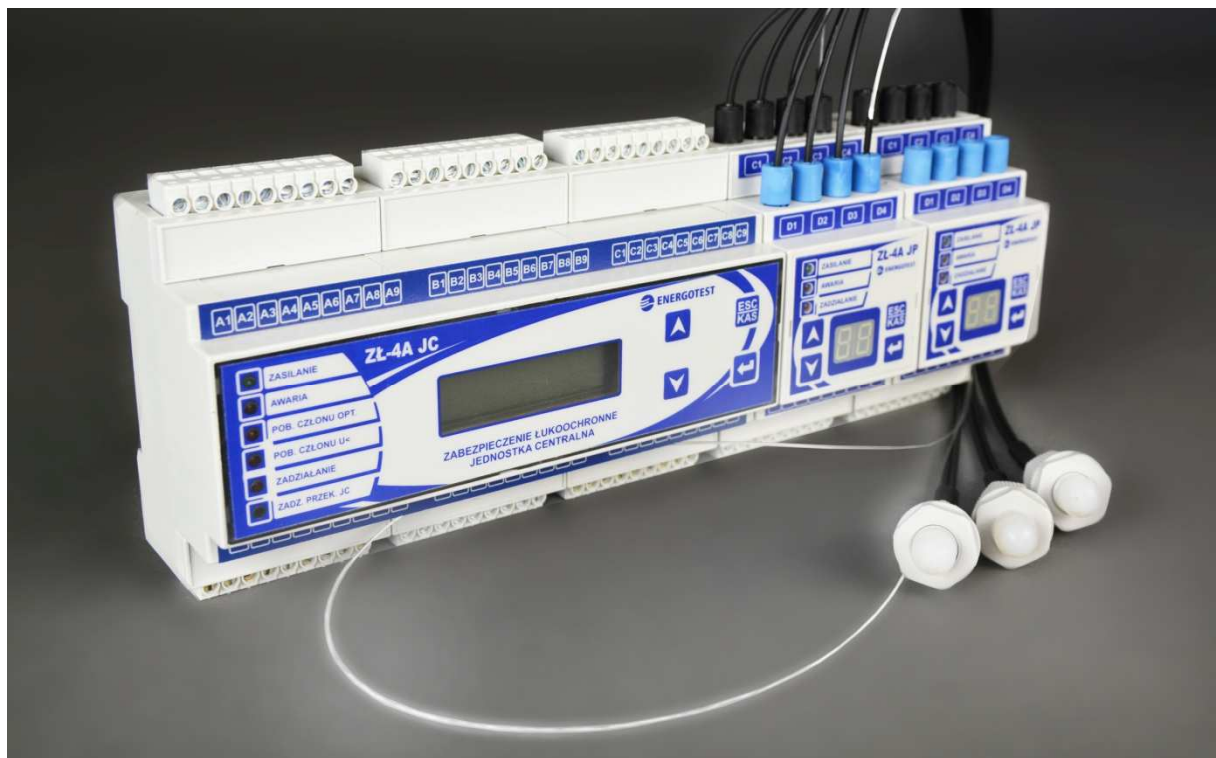


ARC FAULT PROTECTION ZŁ-4A Operating Manual



Gliwice, October 2021

Documentation version	Table of contents points	Description
IU_ZŁ-4A ANG 20181127		Original version
IU_ZŁ-4A ANG 20190710		Addition of records about the maximum length of the fiber reserve.
IU_ZŁ-4A ANG		Change of company details and logo

SPIE Energotest reserves the right for making modifications in products for the purpose of improvement of the technical quality. These modifications may have not been taken into consideration in this documentation yet.

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To contact us:

SPIE Energotest sp. z o.o.

ul. Chorzowska 44B

44-100 Gliwice

Poland

Phone – Central office: 048-32-270 45 18

Phone – Production Department: 048-32-270 45 18 ext. 40

Phone – Marketing: 048-32-270 45 18 ext. 26

E-mail energotest@spie.com

Internet (www): <https://www.spie-energotest.pl>



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1. MEANING OF OPERATING MANUALS

In case of doubts regarding the appropriate interpretation of the manual's content we strongly advise you to contact the manufacturer for further explanation.

We will be grateful for any suggestions, opinions and critical remarks and we kindly ask our customers to deliver them. This may help us to make the manual easier to be used and give consideration to wishes and requirements of the users.

A device, to which the manual has been prepared, does not cover all potential dangers to people and material value. That is why every person, working with this device or performing any activities connected with operating and service of the device, has to be previously trained and has to know potential hazard. It requires careful reading, understanding and obeying the operating manual, particularly remarks concerning safety.

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2. INFORMATION ON COMPLIANCE

A device being the subject of this instruction has been constructed and prepared and it is now manufactured for the purpose of use in industrial environment.

This device is compatible with the following directives:

1. Compatibility System and Market Supervision Act of 13th April 2016 (Dz. U. 2016 pos. 542) as amended.
2. Compatibility System Act of 30th August 2002 (Dz. U. No. 166 pos. 1360) as amended.
3. Decree of Development Minister dated June 2nd 2016 (Dz. U. 2016 pos. 806) implementing the European Parliament Directive Low voltage LVD 2014/35/UE.
4. Polish Act of 13th April 2007 on electromagnetic compatibility (Dz. U. No. 82 pos. 556) implementing the European Parliament Directive EMC 2014/30/UE.

Compliance with the directives has been confirmed by tests performed in laboratory of SPIE Energotest and also independently of the manufacturer measurement and research laboratories in accordance with the requirements of the harmonized standards: PN-EN 60255-27:2014-06 (for the LVD directive) and PN-EN 60255-26:2014-01 (for the EMC directive).

3. Application of the unit

The majority of faults in medium or low voltage switchgears are accompanied by an electric arc, which causes significant damage to equipment and is a great hazard to human life. Breaking a fault within up to 100 ms enables the avoidance of the most serious damage to equipment and decreases a hazard to people in the vicinity of the place of fault occurrence. In case of a long duration of the fault severe injuries, i.e. burns, damage of eyesight etc., including loss of life, can occur. Besides, an irreversible and often complete damage to the switchgear is highly possible.

Because of serious hazard both to people and equipment, according to the regulations of the European countries, including Poland, it is strongly recommended to undertake effective preventive measures in medium and low voltage switchgears as well as in transformer stations to reduce the effects of arc faults.

The fiber optic arc protection type ZŁ-4A localizes arc fault immediately. Considering the time of operation of the currently used circuit breakers (30-50 ms), the protection system type ZŁ-4A guarantees that the switchgear or its specific bay will be switched off within 40-60 ms reducing to minimum the effects of arc faults.

Additional ZŁ-4A features:

- ability to selective switch off the bays where short-circuit appears;
- applying the voltage criterion, providing security of the whole switchgear (no unprotected zones) – this criterion is also beneficial in case of parallel running of two or more incoming feeders on one section of a switchgear;
- ability to operate in case of arc fault;
- simplicity of solution and housing in already operating and newly built/constructed switchgears and transformer stations.

ZŁ-4A is dedicated to LV and MV switchgears and transformer stations. Equipping a switchgear or a transformer station with the arc protection system type ZŁ-4A is the optimal way to meet the requirements of appropriate standards of protection of the personnel and the equipment against destructive effects of arc faults.

4. Safety rules

The following chapter presents the information crucial to appropriate installation and operation of the product. It is assumed that the personnel installing and operating this device is properly qualified and is aware of the potential danger of electrical devices.

The device fulfills all the requirements of obligatory standards and rules regarding safety. It has been carefully constructed in order to meet the user security demand.

Device Installation



The device should be installed in such a location where proper environmental conditions specified in technical data are provided. Ensure adequate cooling of the device. Devices should be properly mounted, protected from mechanical damage and from accidental access of unauthorized persons. Wires cross-sections and types of connections should be consistent with the guidelines given in this manual. Casings are made of plastic and do not require grounding.

Commissioning of device

During a startup of the device its rating plate and the following elements should be carefully checked:

- continuity of grounding circuits,
- fuses,
- compliance of values of auxiliary power supply voltage,
- compliance of values of measured quantities (voltage),
- correctness of applied protections of voltage circuits (nominal values of fuse links or nominal - currents and characteristics of automatic circuit breakers),
- maximum load of relay outputs,
- compliance of voltage values of switching outputs,
- correctness of mounting all circuits .

Operating of device



The unit should operate in the environment specified in technical data.

Personnel operating the device should be authorized and acquainted with operating manuals.

Opening the casing



Before starting any activities that require opening the device casing, one should obligatorily switch off all the measurement and auxiliary voltage supplies and disconnect all terminals blocks. The dangerous voltage may appear on the device elements during 1 min after isolating the circuit.

The applied integrated circuits are very sensitive to electrostatic discharges and that is why opening the unit without special anti-electrostatic equipment may cause its damage.

Service

After installing the device does not require any additional service apart from periodic inspection required by applicable regulations. In case of appearance of any defect the user should ask the producer for help. The producer offers service related to activating, commissioning, guarantee and post guarantee service. Manufacturer's guarantee terms and conditions are described in the guarantee card.

Modifications and changes

For the sake of security all modifications and changes of the unit functions are forbidden. Modifications of the device which have not been certified in writing by the manufacturer, cause loss of any liability claims made against SPIE Energotest Ltd.



Exchange of any elements or components the device is composed of, produced elsewhere, may cause hazard to users and eventually result in incorrect functioning.

SPIE Energotest does not take any responsibility for damage caused by applying inappropriate elements or components of the device.

Nominal data, name plates and stickers

It is obligatory to obey instructions located on the device such as descriptions or name plates and stickers and it is necessary to keep them legible. Plates and stickers, which become damaged or illegible, should be exchanged.

Danger impossible to eliminate



Danger arising from on-load high voltage.

To avoid the electric shock it is suggested not to touch service terminals blocks.

5. ZŁ-4A Technical description

5.1. General information

Fiber optic arc fault protection ZŁ-4A is a device dedicated to diminish all kinds of damage caused by arc faults. It is achieved by fast identification of the fault and breaking all feeder lines of the fault. The device generates tripping signals to the circuit breakers. There are two conditions for the fault identification that have to occur at the same time:

- voltage drop on protected switchgear busbars,
- appearance of arc fault flash.

The device works based on a module structure that includes:

- central unit ZŁ-4A JC,
- bay units ZŁ-4A JP together with optic detectors:
 - point sensor (maximal length 15 m),
 - fiber optic loop (maximal length 5 m),
- executive units ZŁ-4A JW (additional module - optional).

For the sake of data transfer all the system elements are connected by a CAN bus. The protection is supplied by 24V DC. This voltage can be obtained from a site guaranteed 24V DC, or from a power supply suggested by the manufacturer supplied from the guaranteed 220V DC or 230V AC.

A bay unit should be installed in every bay of the switchgear, i.e., incoming feeder, outgoing, coupling, voltage measurement bays, etc. Each bay unit is equipped with 4 optic detectors, that can be installed differently depending on a particular application (the only requirement is to maintain protection of all bay compartments).

For example:

In an outgoing bay detectors 1 and 2 are typically installed in the busbars and CB compartment, and detectors 3 and 4 in the cable drop compartment (see Fig. 1)

In case of more complicated switchgears with a greater number of compartments additional bay unit may be required.



Examples of ZŁ-4A installation for one-section, two-section and dual-mode switchgears are available at SPIE Energotest website.

The best location for the central unit (ZŁ-4A JC) is the voltage measurement bay. Signal from VT should be plugged in to the central unit. Communication between the various protection components is via CAN bus. In case of CAN transmission failure between protection modules, tripping signal is generated based on one condition, namely the light detection.

Because of the tripping signals distribution three protection zones have been defined.

- zone 1 (S1) – includes busbars and CB compartments,

Detection of arc fault by any bay unit (two conditions: activation of optical module and voltage module) in zone 1 results in activation of tripping signal to open the circuit breaker in the current bay and sending information to other bay units in the system. Based on this information all other bay units generate tripping signal to open the circuit breaker in the bays they protect. Moreover, the central unit activates proper actuator relays. All the CB in the protected switchgear are opened.

- zone 2 (S2) – includes cable connection compartments of outgoing bays.

Detection of arc fault by any bay unit (two conditions: activation of optical module and voltage module) in zone 2 results in activation of tripping signal to open the circuit breaker in the current bay (selective activation). Other circuit breakers in the protected switchgear remain closed. Signal indicating a detection of the arc fault in zone 2 is transmitted also to the central unit, that activates proper actuator relays.

- zone 3 (S3) – includes cable connection and circuit breakers (CB) compartments of feeder bays (action without voltage condition).

Detection of arc by any bay unit (one conditions: activation of optical module) in zone 3 results in activation of tripping signal to open the circuit breaker in the protected bay and sending information to central unit. Based on the received information the central unit generates tripping signal to the circuit breaker in the system that supplies the protected switchgear - according to the current configuration of executive relays.

You can find the way of installing ZŁ-4A protection modules in an example of the switchgear in the figure below.

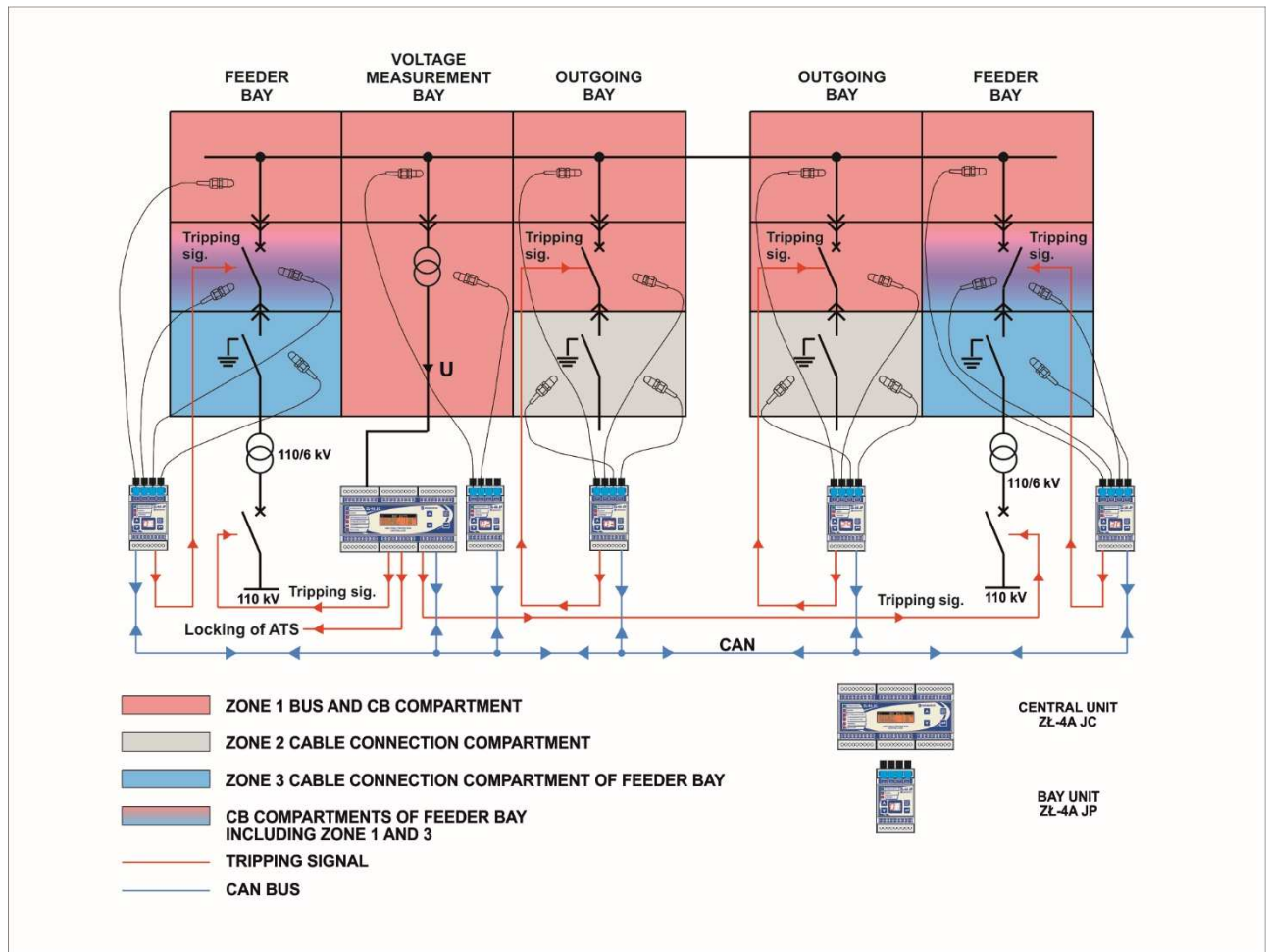


Fig. 1 Example of ZL-4A installing.

The executive unit is an additional module enabling the generation of trip signals. Each unit has one executive relay with normally open contact and one signaling relay with changeover contact. The configuration of the executive relay is identical to that in the central unit. The maximum trip units in the system are 5.

ZL-4A protection can consist of maximal 99 bay units and 5 executive units connected to one central unit. Total length of CAN bus should be less than 250 meters. There are available technical solutions using fiber optic converter which enable the increase of the length of the CAN bus. Delays of the device tripping associated with these solutions are negligible. SPIE Energotest provides a suitable solution as an option for the entire protection system. The requirement of increasing the length of the CAN bus should be notified to SPIE Energotest during ordering.

5.2. Functions of particular protection elements

5.2.1. Central unit.

The central unit supervises the work of the whole ZŁ-4A protection system. Through the central unit the user has access to the information on the current protection states (current settings and signalization of bay and central units) and ability to change the settings ZŁ-4A JC.

The essential functions of the central unit ZŁ-4A JC are the following:

- protection configuration regarding communication between system units,
- configuration of output relays (associating them to the protection zones),
- detection of voltage drop in the switchgear,
- distribution of the voltage drop signal to bay units,
- reading information on settings and activation of bay units,
- controlling data transmission,
- generation of tripping signals by the output relays to the feeder of protected switchgear and of signals of ATS blockade,
- generation of alarm signals in case of incorrect operation of the device,
- sending data by RS 485.

ZŁ-4A JC is equipped with:

- optical signalization (6 LEDs) – with one that is configurable,
- operation panel – LCD display and 4 buttons,
- busbars voltage measurement terminal block,
- CAN terminal block,
- RS-485 terminal block,
- 6 configurable actuator relays with NO contact ,
- 1 signaling relay with switching contact (error signalization).

5.2.2. Bay unit.

Bay units are part of protection which is responsible for detection of arc light, generation of the tripping signal in the current bay and sending communicate regarding detection of arc fault in zone 1, 2 or 3. Each bay unit is equipped with an optical detector control system.

The essential functions of the bay unit ZŁ-4A JP are:

- configuration of optical detectors to the zones 1, 2 or 3,
- detection of arc light in the protected area,
- generation of tripping signal to the circuit breaker in the current bay in case of detection of arc fault in zones 1, 2 or 3,
- generation of the signal of detection of the arc fault by the CAN bus,
- generation of tripping signal to the circuit breaker in case of receiving signal of arc fault in zone 1 from other bay unit,
- generation of alarm signals indicating wrong functioning of the device,
- testing optical detectors.

Bay unit ZŁ-4A JP is built with:

- optical signalization (3 LEDs),
- operation panel (alphanumeric display and 4 buttons),
- CAN terminal block,
- 4 optical inputs for optical detectors,
- 4 optical outputs for optical detectors,
- 1 executive relay with closing contact (NO).

5.2.3. Executive unit.

Executive units are part of protection which is responsible for generation of trip signals.

The essential functions of the executive unit ZŁ-4A JW are:

- generation of tripping signal to the circuit breaker,
- signaling of activation JW unit,
- generation of alarm signals in case of incorrect operation of the device.

Executive unit ZŁ-4A JW is built with:

- optical signalization (3 LEDs),
- operation panel (alphanumeric display and 4 buttons),
- CAN terminal block,
- 1 executive relay with closing contact (NO),
- 1 signaling relay with changeover contact.

5.2.4. Optical detectors.

Optical detectors are installed directly in the protected area of the switchgear (busbars, CB, cable connection compartment) and they detect light of the arc fault. This light is transmitted by a fiber to the optical detectors in the bay unit. The construction of the fiber optics detector allows one for fiber integrity testing. Maximum length of a fiber optic cable for a point sensor is 15 m, while for the fiber optic loop it is 5 m. Detectors delivered by SPIE Energotest are ready for installation.

5.2.5. Power supply.

A power supply can be connected to the guaranteed 220V DC or 230V AC and is a source of 24V DC for all the elements of the protection. Each unit system consisting of a central unit and bay units should be supplied by a separate power supply. One is forbidden to supply other devices with the power supply designed for ZŁ-4A protection.

5.3. ZŁ-4A front panels

5.3.1. Central unit

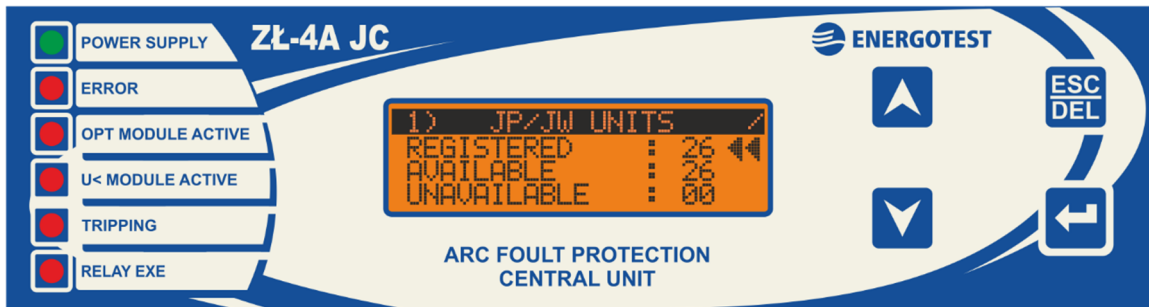


Fig. 2 Central unit front panel ZŁ-4A JC.

Front panel of the central unit is equipped with:

- 6 signaling LEDs:
 - “POWER SUPPLY” – indicates the presence of power supply voltage,
 - “ERROR” – indicates malfunctioning of the device, error details are displayed on LCD display,
 - “OPT MODULE ACTIVE” – indicates that the optical module of at least one bay unit has been activated. Continuous light means a permanent activation of the optical module. Blinking light informs that there has been a temporary activation of the optical module,
 - “U< MODULE ACTIVE” – indicates that voltage module has been activated and there is a voltage drop in the switchgear,
 - “TRIPPING” – indicates that ZŁ-4A protection has generated a tripping signal after an arc fault detection,
 - “RELAY EXE” – indicates activation of an executive relay programmed by the user (default – LED activation in case of an activation of any executive relay).
- LCD display – it is used for presenting various information on states of the protection system and during its configuration,
- 4 buttons – for operation of the panel control:
 -  UP – increasing the value, or menu scrolling,
 -  DOWN – decreasing the value, or menu scrolling,
 -  ENTER – settings approval, enter into menu mode,
 -  ESC /DEL – tripping reset, go to master menu.

5.3.2. Bay unit



Fig. 3 Front panel of a bay unit ZŁ-4A JP.

Front panel of a bay unit is equipped with:

- 3 signaling LEDs:
 - “POWER SUPPLY” – indicates the presence of power supply voltage,
 - “ERROR” – indicates malfunctioning of the device, error code are displayed on LCD display,
 - “TRIPPING” – indicates that ZŁ-4A protection has generated a tripping signal after an arc fault detection,
- two digit seven segment LED display – indicates a state of the bay unit, allows one to change a configuration of the unit,
- 4 buttons – for operation of the panel control:
 -  UP – increasing the value, or menu scrolling,
 -  DOWN – decreasing the value, or menu scrolling,
 -  ENTER – settings approval, enter into menu mode,
 -  ESC /DEL – tripping reset, menu mode exit.

5.3.3. Executive unit



Fig. 4 Front panel of an executive unit ZŁ-4A JW.

Front panel of an executive unit is equipped with:

- 3 signaling LEDs:
 - “POWER SUPPLY” – indicates the presence of power supply voltage,
 - “ERROR” – indicates malfunctioning of the device,
 - “TRIPPING” – indicates that unit has generated a tripping signal,
- two digit seven segment LED display – indicates a state of the executive unit, allows one to change a configuration of the unit,
- 4 buttons – for operation of the panel control:
 -  UP – increasing the value,
 -  DOWN – decreasing the value,
 -  ENTER – settings approval, enter into menu mode,
 -  ESC /DEL – tripping reset, menu mode exit.

6. Technical data

Central unit

Measurement voltage	Rated voltage U_n	100 V, 50Hz
	Continuous thermal withstand value	1.5 U_n
	Thermal withstand value defined for 10 sec	2.5 U_n
	Power consumption	< 0.5 VA
	Factory setting of voltage for 3-phase short-circuit	0.7 U_n
	Accuracy class	5%
	Measurement circuit separation	2 kV
Auxiliary voltage	Rated voltage U_{pn}	24 V DC
	Operating range of voltage	0.8...1.1 U_{pn}
	Max voltage level	1.3 U_{pn} (perm)
	Power consumption	6 W
Outputs Relay tripping and signaling		
	Max contact voltage	440 V AC; 250 V DC
	Max continuous current	8 A
	Max power AC1	2000 VA
Time	Up to the contact closing	< 8 ms
Insulation electrical	Circuit insulation rated voltage	250 V
	Electrical strength of insulation	2 kV/ 50 Hz /1 min
	Between opened relay contacts	500 V/ 50 Hz/1 min
Environmental conditions	Rated temperature	-10 ... +55 °C
	Temperature limits	-25 and +70 °C
	Humidity	45 ... 75 %
	Atmospheric pressure	86 ...106 kPa
	Vibrations endurance	1 st class PN-EN 60255-21-1
Electromagnetic compatibility (EMC)	Test class	III
	Max time of supply voltage interruption	20 ms
Casing	To be mounted on a rail TS-35 type RAILTEC C	
	Dimensions	159 / 90 / 58 mm
	Weight	Approx. 0.42 kg
	Degree of protection	IP20
	clamps	Terminal block

Bay unit

Auxiliary voltage	Rated voltage U_{pn}	24 V DC
	Operating range of voltage	0.8 ... 1.1 U_{pn}
	Max voltage level	1.3 U_{pn} (perm)
	Power consumption	1.5 W
Outputs Relay tripping		
	Max contact voltage	440 V AC; 250 V DC
	Max continuous current	8 A
	Max power AC1	2000 VA
Time	Up to the contact closing	< 8 ms
Insulation electrical	Circuit rated insulation voltage	250 V
	Electrical strength of insulation	2 kV/50 Hz/ 1min
	Between opened relay contacts	500 V/ 50Hz/ 1min
Environmental conditions	Rated temperature	-10 ... +55 °C
	Temperature limits	-25 and +70 °C
	Humidity	45 ... 75%
	Atmospheric pressure	86 ... 106 kPa
Electromagnetic compatibility (EMC)	Vibrations endurance	1 st class PN-EN 60255-21-1
	Test class	III
Casing	Max power supply break	20 ms
	To be mounted on a rail TS-35 type RAILTEC C	
	Dimensions	53 / 90 / 58 mm
	Weight	Approx. 0,12 kg
	Degree of protection	IP20
	clamps	Terminal block

Executive unit

Auxiliary voltage	Rated voltage U_{pn}	24 V DC
	Operating range of voltage	0.8 ... 1.1 U_{pn}
	Max voltage level	1.3 U_{pn} (perm)
	Power consumption	1.5 W
Outputs Relay		
tripping	Max contact voltage	440 V AC; 250 V DC
	Max continuous current	8 A
	Max power AC1	2500 VA
signaling	Max contact voltage	400 V AC; 250 V DC
	Max continuous current	6 A
	Max power AC1	1500 VA
Time	Up to the tripping contact closing	< 8 ms
Insulation electrical	Circuit rated insulation voltage	250 V
	Electrical strength of insulation	2 kV/50 Hz/ 1min
	Between opened relay contacts	500 V/ 50Hz/ 1min
Environmental conditions	Rated temperature	-10 ... +55 oC
	Temperature limits	-25 and +70 oC
	Humidity	45 ... 75%
	Atmospheric pressure	86 ... 106 kPa
	Vibrations endurance	1st class PN-EN 60255-21-1
Electromagnetic compatibility (EMC)	Test class	III
	Max power supply break	20 ms
Casing	To be mounted on a rail TS-35 type RAILTEC C	
	Dimensions	53 / 90 / 58 mm
	Weight	Approx. 0,12 kg
	Degree of protection	IP20
	clamps	Terminal block

Optical detector	Type	Point detector
	External diameter	2.2 x 4.4 mm
	Bending radius	25 mm
	Rated temperature limits	-50...+ 70° C
	Max tensile strength	5 N
	Length	max 15 m
	Max. fiber reserve	1 m
	Type	Fiber loop detector
	External diameter	1 mm
	Bending radius	25 mm
	Rated temperature limits	-50...+ 70° C
	Max tensile strength	5 N
	Length	max 5 m
	Max. fiber reserve	1 m

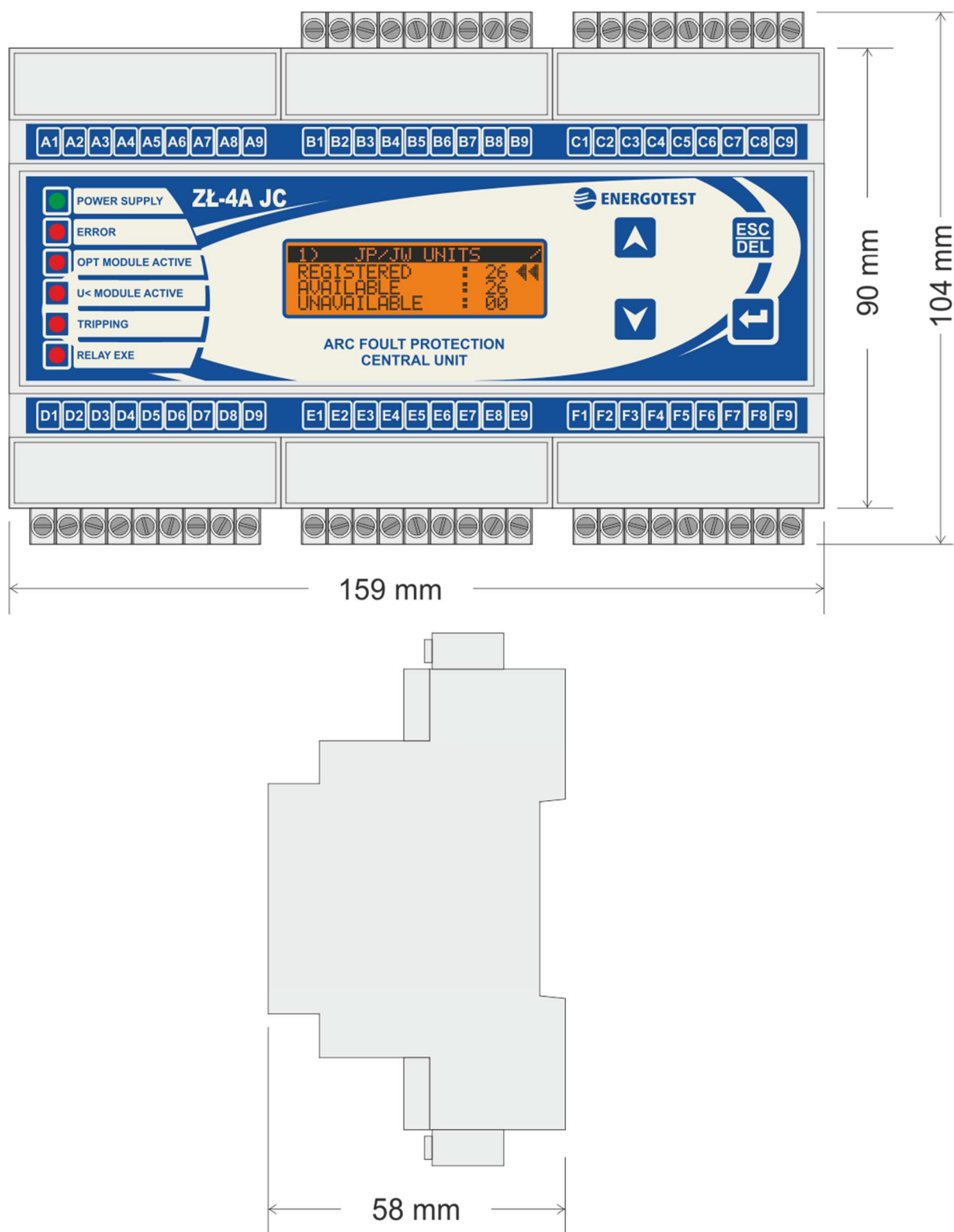


Fig. 5 ZŁ-4A JC dimensions.

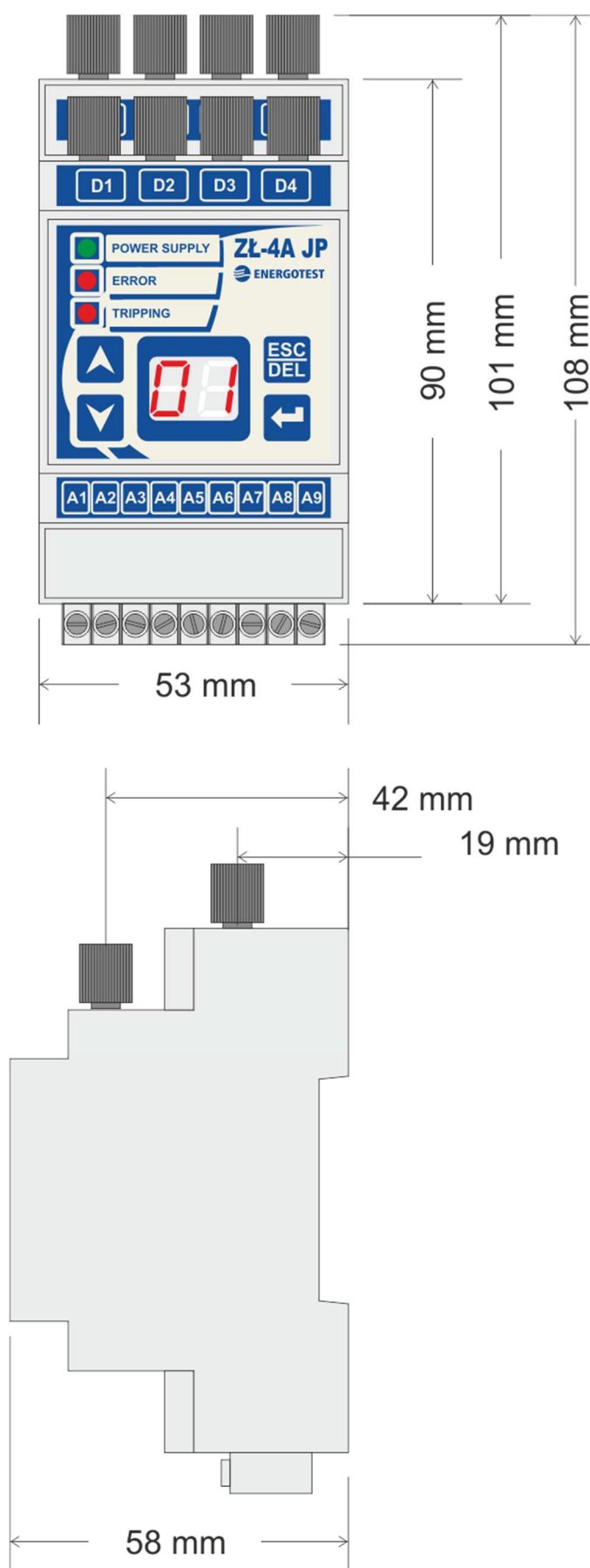


Fig. 6 ZŁ-4A JP dimensions.

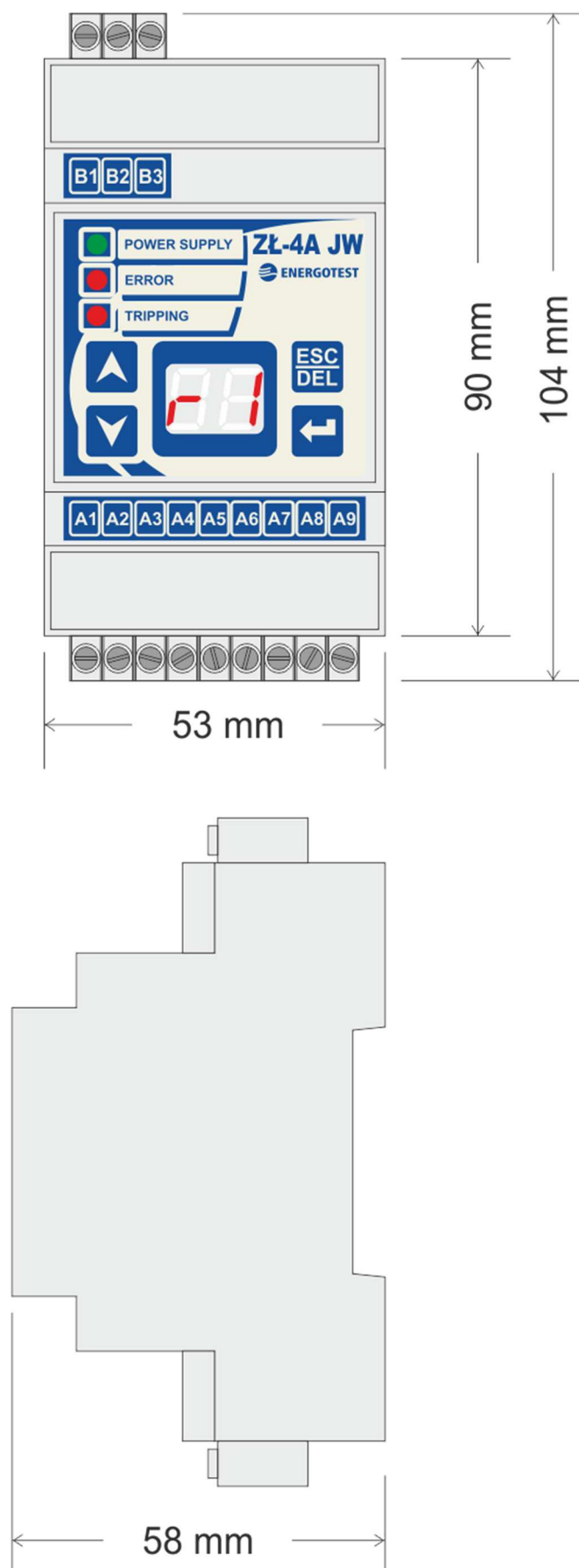


Fig. 7 ZŁ-4A JW dimensions.

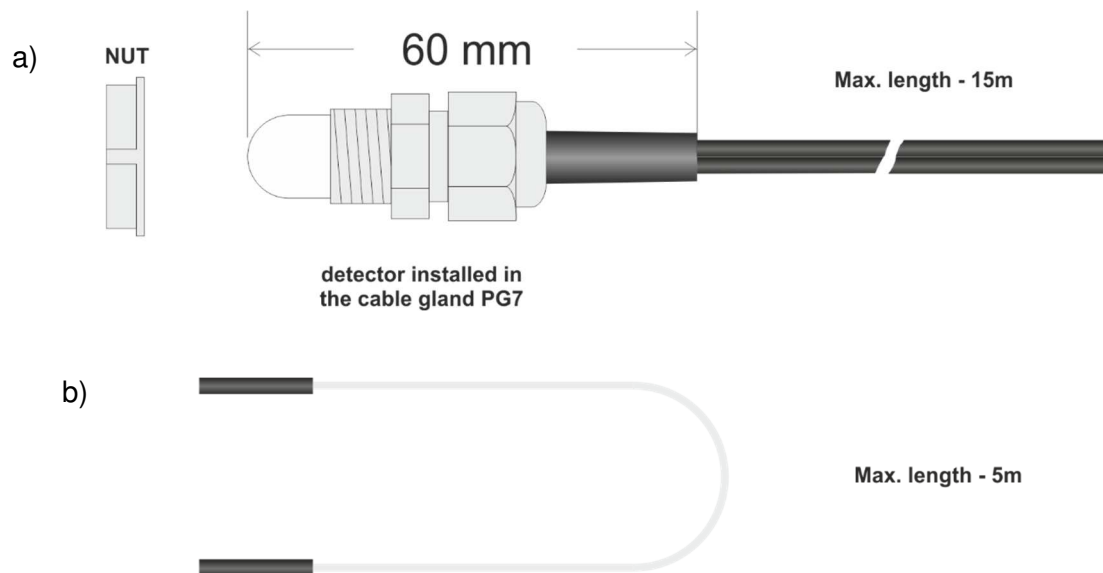


Fig. 8 Optical detector dimensions: a) point detector, b) fiber optic loop.

7. List of applied standards

During constructing and producing of the arc protection type ZŁ-4A there have been such standards applied, which followed provide assumed rules and safety measures. However, it is possible under the condition that the user will follow the instruction and guidelines for installing, operating and maintenance of the device.

The arc protection type ZŁ-4A fulfills all the standards specified in respective directives: low-voltage and electromagnetic compatibility, in accordance with harmonized standards mentioned below.

PN-EN 60255-27:2014-06 Measuring relays and protection equipment. Part 27: Product safety requirements, harmonized with LVD directive;

PN-EN 60255-26:2014-01 Measuring relays and protection equipment. Part 26: Electromagnetic Compatibility Requirements, harmonized with EMC directive.

PN-EN 60255-1:2010E Measuring relays and protection equipment - Part 1: Common requirements.

8. Information on completeness

The delivery of the arc protection system type ZŁ-4A includes:

- Central unit ZŁ-4A JC,
- Bay unit ZŁ-4A JP (number as ordered),
- Executive unit ZŁ-4A JW (number as ordered),
- Optical detectors, 4 pieces for each bay unit. As a standard solution SPIE Energotest delivers 5m point detectors. Other fiber length should be specified in the order; the maximum length of the fiber reserve is 1 meter,
- Power supply,
- Product fiche,
- Guarantee certificate

Moreover, upon request the manufacturer delivers:

- Operating manual printed,
- Device test protocols.

9. Mounting



SPIE Energotest recommends that before the first plugging in the device should be placed in the room it is going to be installed, for at least two hours. This action is intended to compensate the temperature and avoid humidity.

All units of the arc fault protections type ZŁ-4A are dedicated to be mounted on rails type TS-35 inside relay compartments of the protected switchgear. It is recommended to locate ZŁ-4A JP bay units in such a place where fiber optic elements are easy to be installed. One needs to take into consideration the required value of the bending radius (in accordance with technical data of fiber optics) and the limited number of bends. Casings of units do not require the grounding connection thanks to the type of the material they are composed of. Moreover, they do not demand applying additional mounting elements. In Fig. 9 space requirements for installing the device are presented.

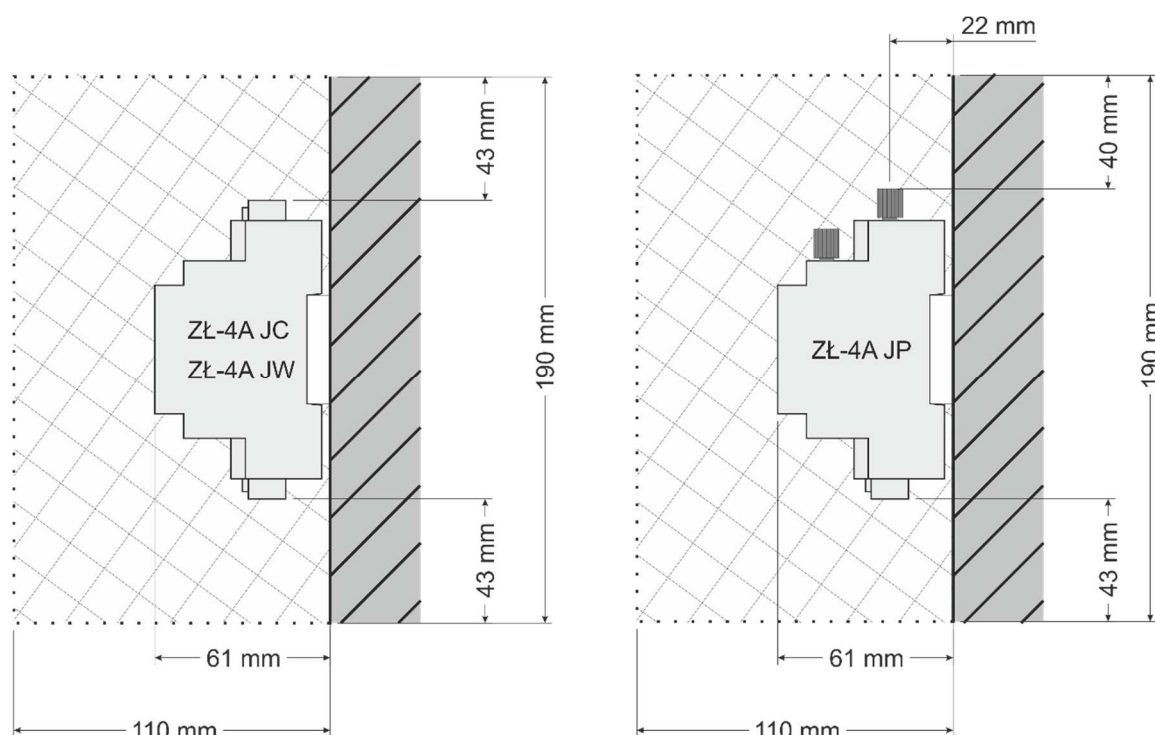


Fig. 9 Space requirements for installing the device.

ZŁ-4A elements connections are presented in figures Fig. 14, Fig. 15 and Fig. 16. Central units, bay units and executive units should be connected with a shielded twisted-pair cable. One pair of cables is used for power supply (24V DC) and the other is used for data transmission (CAN). Connections between elements can be organized as a chain structure with or without the use of intermediate terminals. Cable length between clamps in the terminal and the bay/executive unit should be shorter than 0.5 meter. Respective connections are presented in figures Fig. 10, Fig. 12 and Fig. 11, Fig. 13.

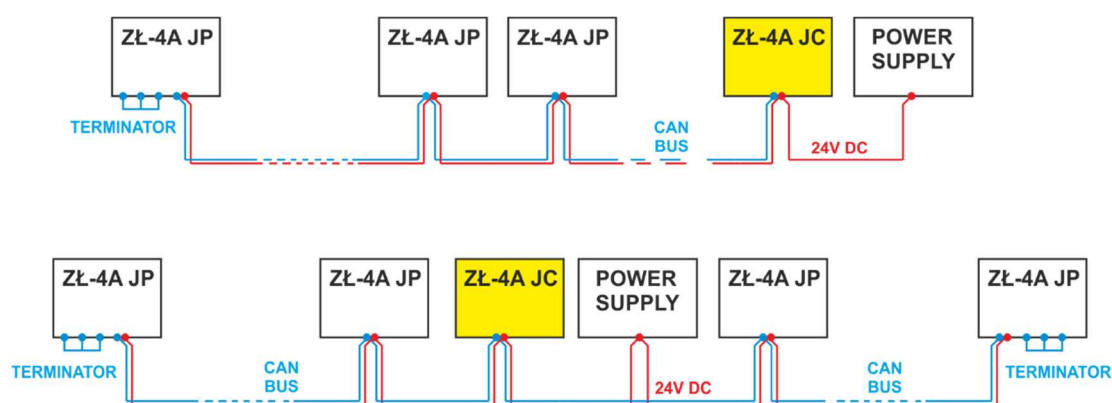


Fig. 10 ZŁ-4A elements connection (without terminal).

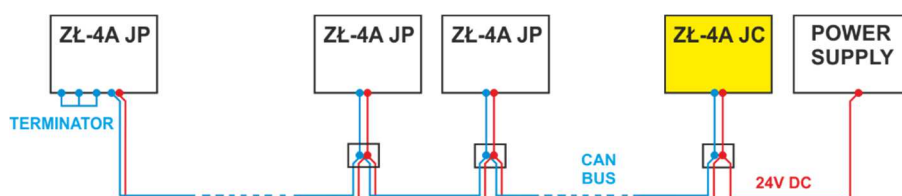


Fig. 11 ZŁ-4A elements connection (with terminal).

Cable diameter should be adjusted to the length of the cable which connects the elements of the arc protection (see Table 1). For the cable length lesser than 100 m the diameter of a single conductor should be not less than 0.5 mm² (screened cable type LIYCY-P 2x2x0.5 mm² is recommended). While for the cable length greater than 100 m the conductor diameter should be not less than 1 mm² LIYCY-P 2x2x1 mm² recommended.

Connection of units to CAN bus:

- CAN L clamps (A9 for JP/JW, B1 for JC) with CAN L line
- CAN H clamps (A8 for JP/JW, B2 for JC) with CAN H line

In case of the last unit in a chain the terminator should be activated by closing contacts CAN RL, CAN RH, CAN R (A5, A6, A7 for JP, B3, B4, B5 for JC). Connections diagram of several ZŁ-4A devices is presented in figures Fig. 14, Fig. 15 and Fig. 16. The cable screen should be connected to the PE clamp in the place of the JC installation. In other places the screen should be terminated as close as possible to the JP/JW and then insulated.

Table 1 Conductors ensuring secure connections

	Conductor cross section	Rated data
CAN BUS and 24V DC power supply (<100 m)	2x2x0.5 mm ²	LIYCY-P, 250V rms; or dedicated cable to CAN BUS
CAN BUS and 24V DC power supply (>100 m)	2x2x1 mm ²	
RS485	0,35-0,75 mm ²	Dedicated cable to RS485
External conductor connections	1.5 mm ²	250V rms;
Grounding	≥ 2.5 mm ²	

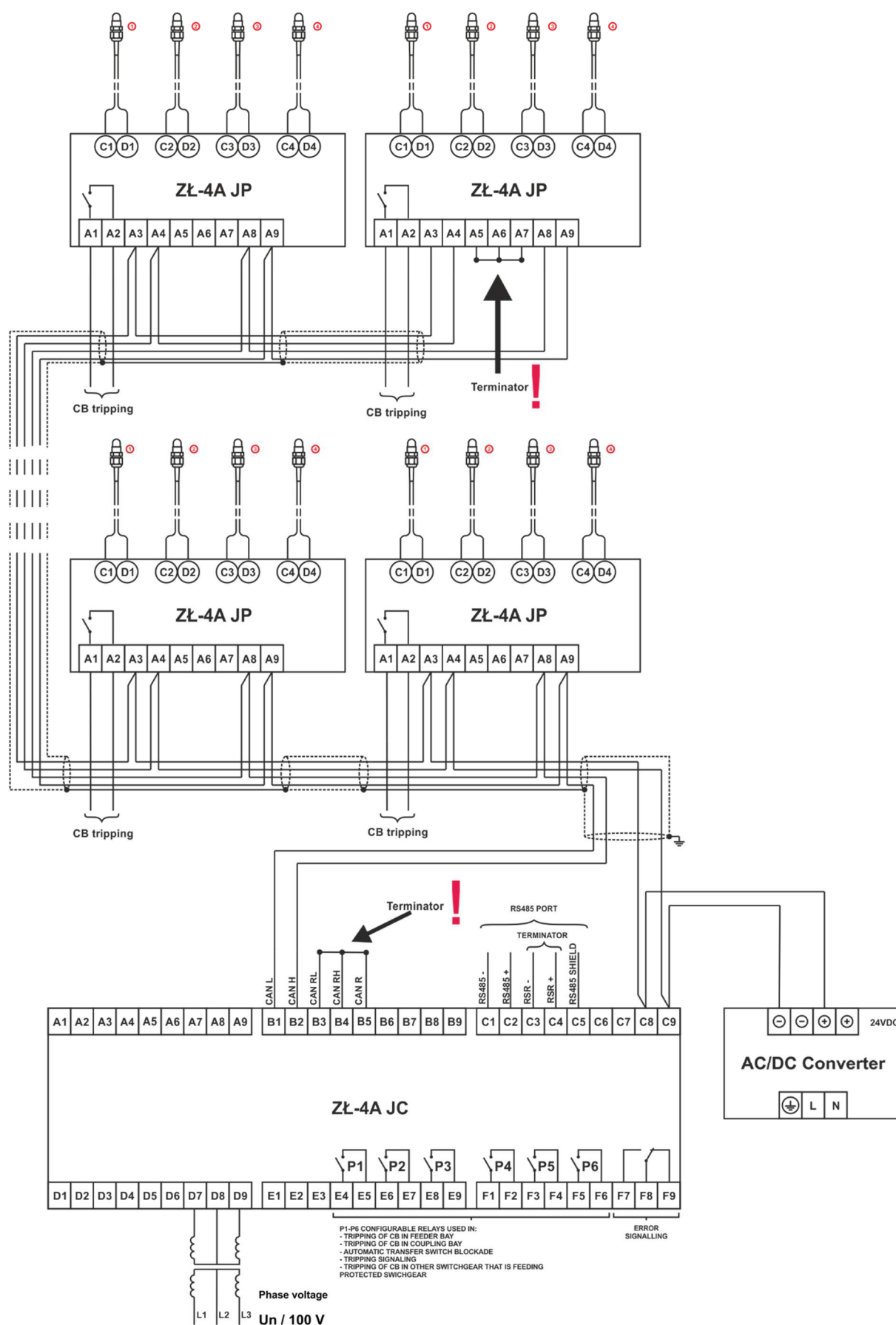


Fig. 12 Detailed diagram of ZŁ-4A elements connections (chain, without an intermediate terminal).

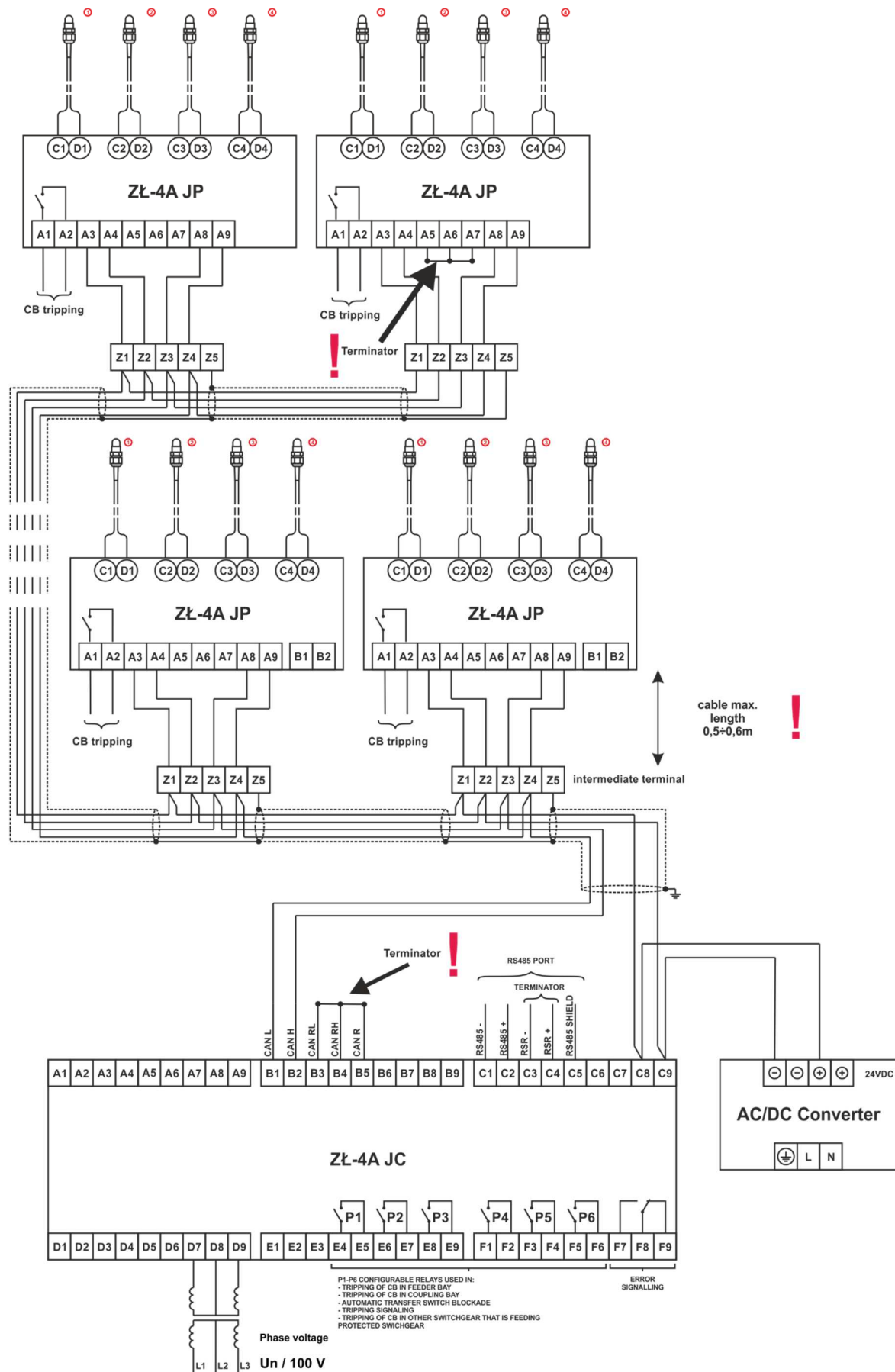


Fig. 13 Detailed diagram of ZŁ-4A elements connections
(chain, with an intermediate terminal).

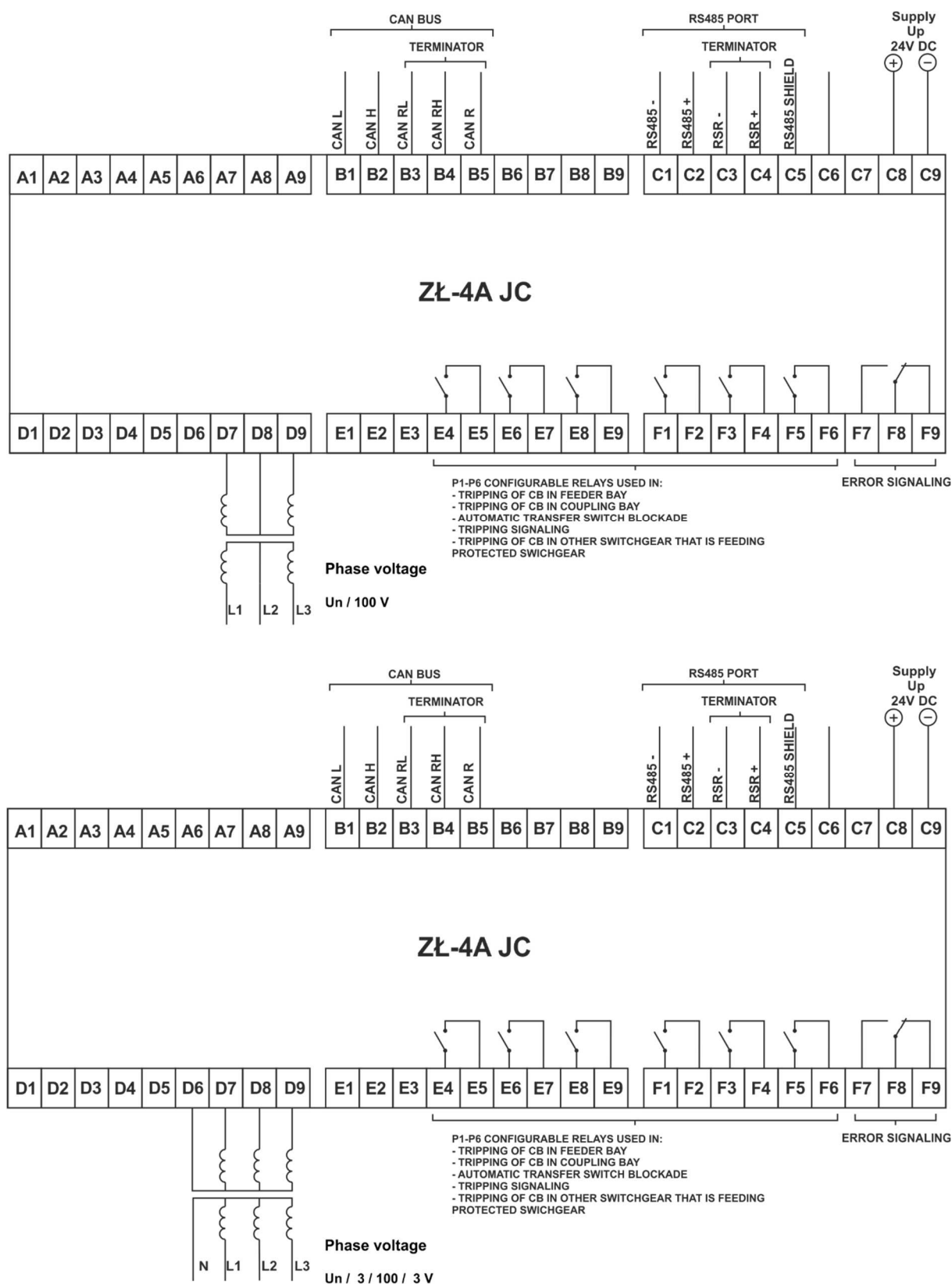


Fig. 14 ZŁ-4A JC – external circuit connection.

Example

location of
optical sensor:

- ① optical sensor in busbar compartment
- ② optical sensor in CB compartment
- ③ optical sensors in outgoing compartment
- ④ optical sensor in outgoing compartment

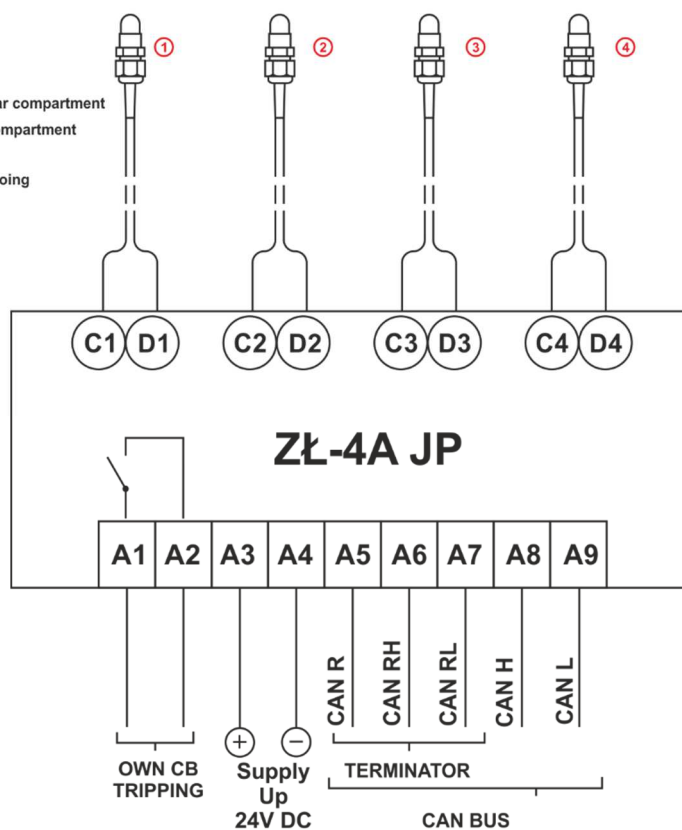


Fig. 15 ZŁ-4A JP – external circuit connection.

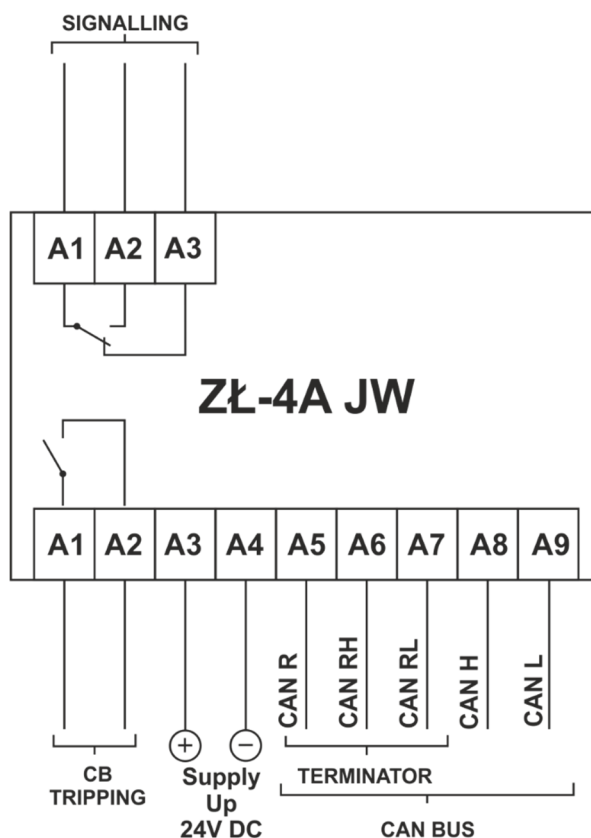


Fig. 16 ZŁ-4A JW – external circuit connection.

Installation of bay/executive units in case the CAN bus length is over 250 meters.

Total length electrical connections of CAN bus should be less than 250 meters. At longer lengths, interference or failure of communication may occur. In ZŁ-4A systems with CAN bus lengths greater than 250 m, a set of CAN/FO fiber optic converters must be installed. Total length electrical connections to the converter terminals should be less than 250 meters. The maximum length of fiber optic connections between converters is several kilometers (depending on the converter type). Delays of the device tripping associated with these solutions are negligible. An example of such a solution is shown in Fig. 17. SPIE Energotest provides a suitable solution as an option for the entire protection system. The requirement of increasing the length of the CAN bus should be notified to SPIE Energotest during ordering.

Optical elements mounting

During installation of the protection device it is important to pay particular attention to the correct mounting of optic elements of the device, in particular:

- conservation of safe bend radius for fiber optic,
- arrangement of fiber optic in such places, where the damage during routine maintenance work is highly unlikely,
- keeping clear of moving parts of the switchgear: drives, pulling elements of interlocks, limit switches etc.,
- if possible, laying the fiber optics independently (apart from other conductors)
- limiting the length of fiber optic into a frontal sensor (without applying spare fiber); the maximum length of the fiber reserve is 1 meter.

The optic elements should be mounted with the use of plastic mounting strips and self-adhesive grips according to the tips mentioned above. Transitions of optic elements into particular compartments of the protected switchgear should be sealed with the use of plastic seals PG-7 for instance (13 mm diameter holes are necessary to use them).

Optical detectors with plastic fibers are connected to the optical inputs of bay units according to what is presented in Fig. 15. The point sensor and the fiber optic loop are interchangeable. Properly cut fiber optic cable does not need any additional preparations or connectors. Proper installation is ensured by the construction of the optical detector output of the bay unit.

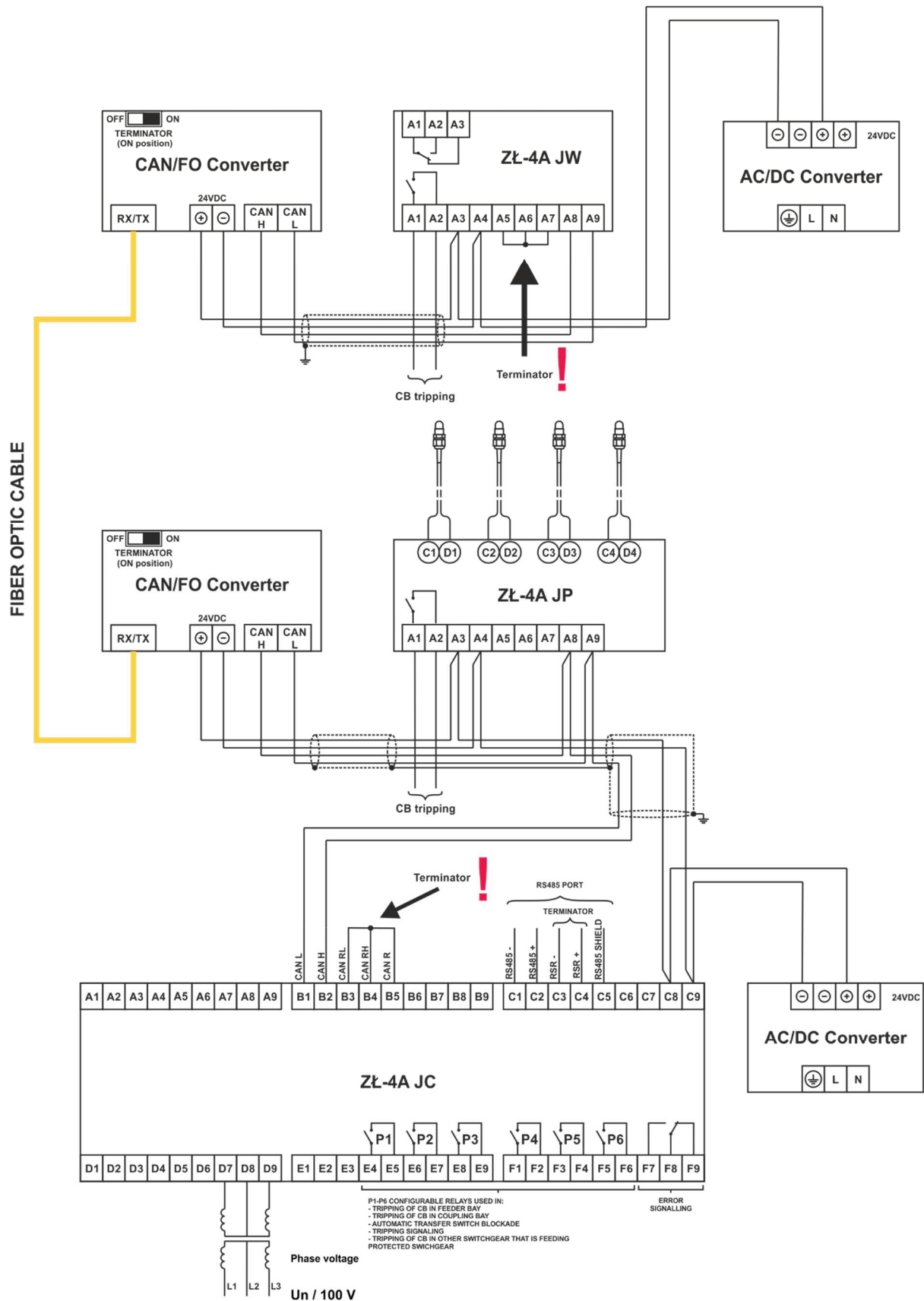


Fig. 17 Detailed diagram of ZŁ-4A elements connections (chain, without an intermediate terminal) with CAN/FO converter and executive unit.

10. Starting up

10.1. Registration of bay units

Once the mounting of the optic elements of the arc fault protection ZŁ-4A is completed and all the connections are checked, one is allowed to start up the device. One should also keep in mind that during the start-up process unnecessary tripping signals may be generated.

After supplying all units with 24 V DC it is possible to start the device configuration. The first stage is to assign each bay unit the unique network address ranged 1..99 and each executive unit the unique network address ranged 1..5. It is recommended for the network address to be adequate to the bay number in which the bay unit is installed. Then, it is easier to localize the bay unit during work with the central unit operating panel. For more details on the network addresses check point 11.3 of the following manual.

Next step is to register all bay and executive units in the central unit. It is necessary for a proper operation of the protection system. In order to register bay and executive units in the central unit please follow point 13.3.7 - Fig. 44, by choosing option "SCAN & INSTALL". Then, this step is made automatically by the central unit. Each network address of respective bay and executive units can be found on the page 1) JP/JW UNITS in "REGISTERED" Submenu. There is a possibility to add or remove a single bay or executive unit (more details in Fig. 43).

Attention!

Assigning IP address to a bay/executive unit is not equivalent to its registration in the system. Registration has to be done in the central unit. An unregistered bay or executive unit is not fully functional.

A change of a bay or executive unit IP address means that it has to be registered in the system again with a new IP address. In case when an unregistered bay unit will detect an arc fault the tripping algorithm is only partially executed.

After configuration of the protection system one needs to check the number of the registered units and the number of units present in the network. It is possible on page 1) JP/JW UNITS. The number of registered devices should be the same as the number of assembled units.

10.2. Optical inputs configuration

Optical inputs are configured by the manufacturer. If any change in optical inputs is necessary follow the instruction point 11.3.

Default configuration:

- C1 input – associated to the zone 1,
- C2 input – associated to the zone 1,
- C3 input – associated to the zone 2,
- C4 input – associated to the zone 2.

10.3. Optical inputs checking

10.3.1. Check with an external light source

In order to activate optical inputs one has to use a light source of ~40 klux and place it 20 cm away from the sensor. It is also possible to use a flash light. Information on optical module activation will be visible on the central unit panel – Fig. 21. A message on a temporary activation will be visible also on page 3) ACTIVATION of the central unit operation panel. “OPT MODULE ACTIVE” LED will be illuminated with pulsed light.

During continuous lighting on the sensor after 5 s the inputs will become permanently blocked and “ERROR” LED will light both on JP and JC. “OPT MODULE ACTIVE” LED will light steadily. Detailed information on the activation will be available on the central unit operation panel. The signaling relay contact (F8, F9) JC will be closed. After removing the light source, information on the temporary activation of the optical module will remain visible on the panel. It should be removed by pressing a button  on the bay unit control panel.

Attention!

If U< module is activated during optical inputs checking with an external light source, some tripping signals may be generated by the protection according to the current sensors configuration.

10.3.2. Check with an embedded test.

Optical system (optical inputs, optical outputs and fiber optic detectors) can be checked with the use of embedded tests. One can run such tests from the level of both the central unit JC and the bay unit JP.

- In order to run a test of optical system from the level of the central unit JC one needs to follow instructions given in 13.3.8 of this manual. The results of the performed tests clearly define which of the device optical system are damaged. In case of the malfunction “ERROR” LED will light on the front panel of the central unit JC and the signaling relay contact (F8, F9) JC will be closed. Detailed information on the failure will be available on the page 6) ALARMS of the JC operating panel. On the display of the bay unit JP in which the failure has been detected error message  will appear. Information on the status of the optical system is stored until next test run or until being cleared by pressing button .
- In order to run tests of optical system from the level of the bay unit JP one needs to follow instructions given in 11.6 of this manual. The test result is visible on the front panel of the tested bay unit JP as well as on the operating panel of the central unit JC. The bay unit JP makes information about which of the optical system is damaged available for 30 s. Afterwards the test results can be obtained with the help of the operating panel of the JC. In case of the optical system malfunction detection error message  will appear on the display of the bay unit JP. At the same time “ERROR” LED will light on the front panel of the central unit JC and the signaling relay contact (F8, F9) JC will be closed. Detailed information on the failure will be available on the page 6) ALARMS of the JC operating panel. Test results are stored until next test run or until being cleared by pressing button .

Attention!

Optical system checking with the use of the embedded tests is perfectly safe. There is no hazard of tripping signals generation even in case of U< module being activated.

10.4. Voltage measurement input checking

For voltage measurement input checking measurement voltage phases should be disconnected one by one. In case of a proper detection of the voltage drop "U< MODULE ACTIVE" LED on the central unit control panel will be illuminated. It will be also visible on page 3) ACTIVATION of the central unit control panel. Bay units will signal information on the voltage drop detection by displaying a respective message, namely . After supplying the measurement voltage the U< module will be deactivated immediately.

11. Using of ZŁ-4A JP control panel

11.1. Information on software version

Immediately after power supply connecting all the LED's and all the segments of the display are illuminated. After a few seconds an actual software version number will be displayed. A full number is displayed in two stages (Fig. 18) because the display has only two digits.

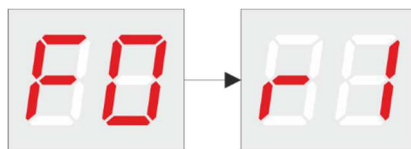


Fig. 18 Actual software version.

Next the bay unit will revert to "ready" status and its network address is visible on the display (under the condition that it has been configured).



Fig. 19 Message displayed for a bay unit without a network address.

In case when a bay unit does not have a configured network address "--" symbol will be displayed. Standard setting is number 01.



Fig. 20 Information displayed if a bay unit does have a configured network address.

11.2. “Ready” status

“Ready” is the basic mode of ZŁ-4A JP. In this mode green LED “POWER SUPPLY” is lighted on the operating panel. Network address is shown on the display. The unit is ready for activation.

Optical inputs and the executive relay status can be checked in this mode (see Fig. 21). It is possible after pressing  or  button.

Information on the display:

Digit – number of an optical input,

“L” – low state of an optical input (light detector not activated),

“H” – high state of an optical input (light detector continuously activated),

Pulsing “L” – information that the light detector has been temporarily activated but at the moment it is not activated,

“r” – the executive relay,

“rL” – the executive relay is not activated (contact open),

“rH” – the executive relay is activated (contact closed).

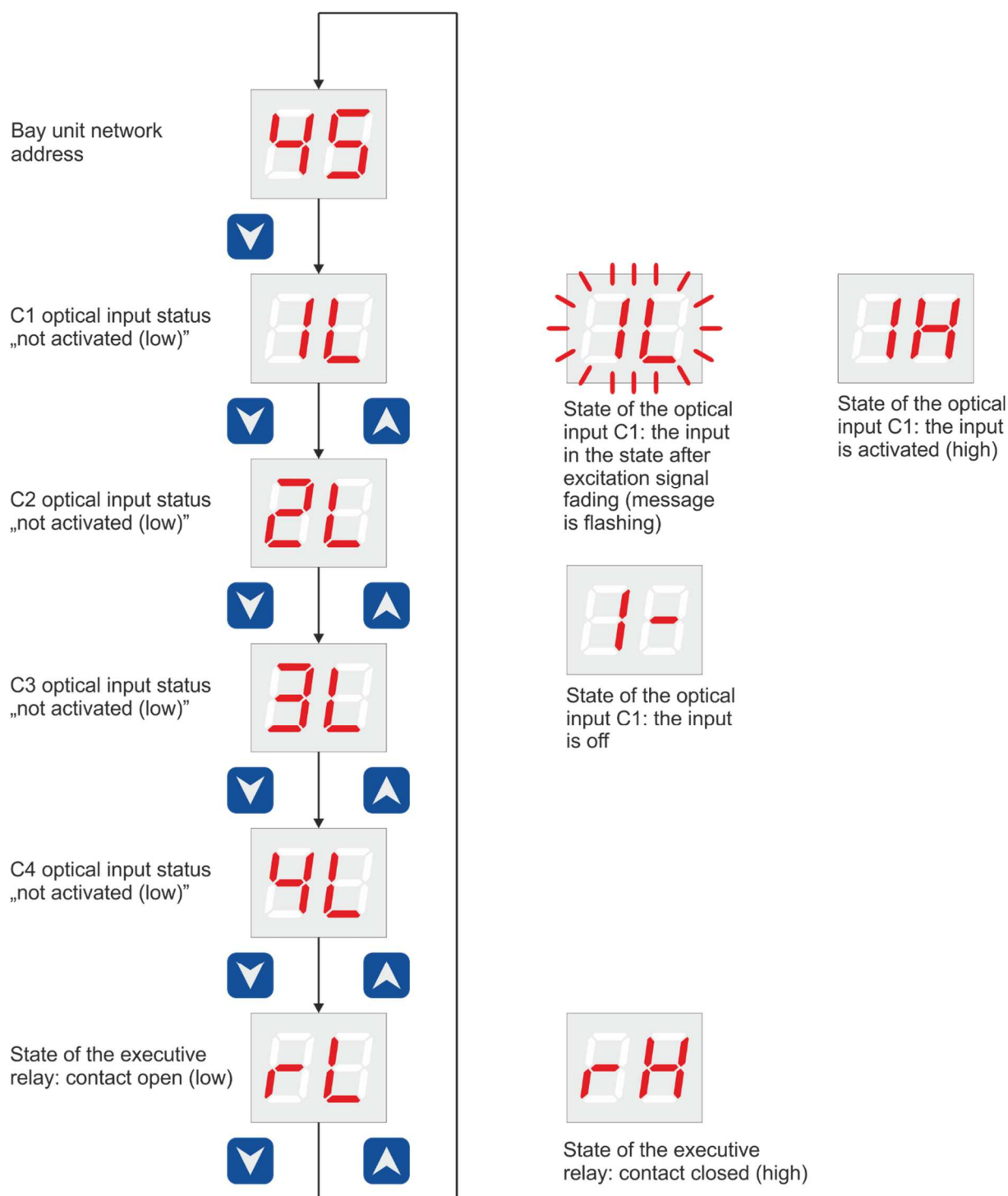


Fig. 21 Information on JP control panel: states of optical inputs and executive relay.

ZŁ-4A is permanently controlling the voltage on the protected switchgear busbars. In case when the voltage will drop below the level set in the settings, the voltage module “U<” will be activated. A respective detection is made in central unit, and a proper message is sent to all the bay units through CAN bus.

A pulsing message “UL” is shown on the front panels of bay units (Fig. 22). The device changes its mode into “single criterion” mode. In such a situation a light detecting results in a tripping signal generation.

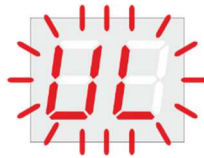


Fig. 22 Voltage drop message.

11.3. Bay unit configuration

In order to enter into the “configuration” mode press  button for 3 s. After that the configurable parameters will be displayed one by one (see Fig. 23)

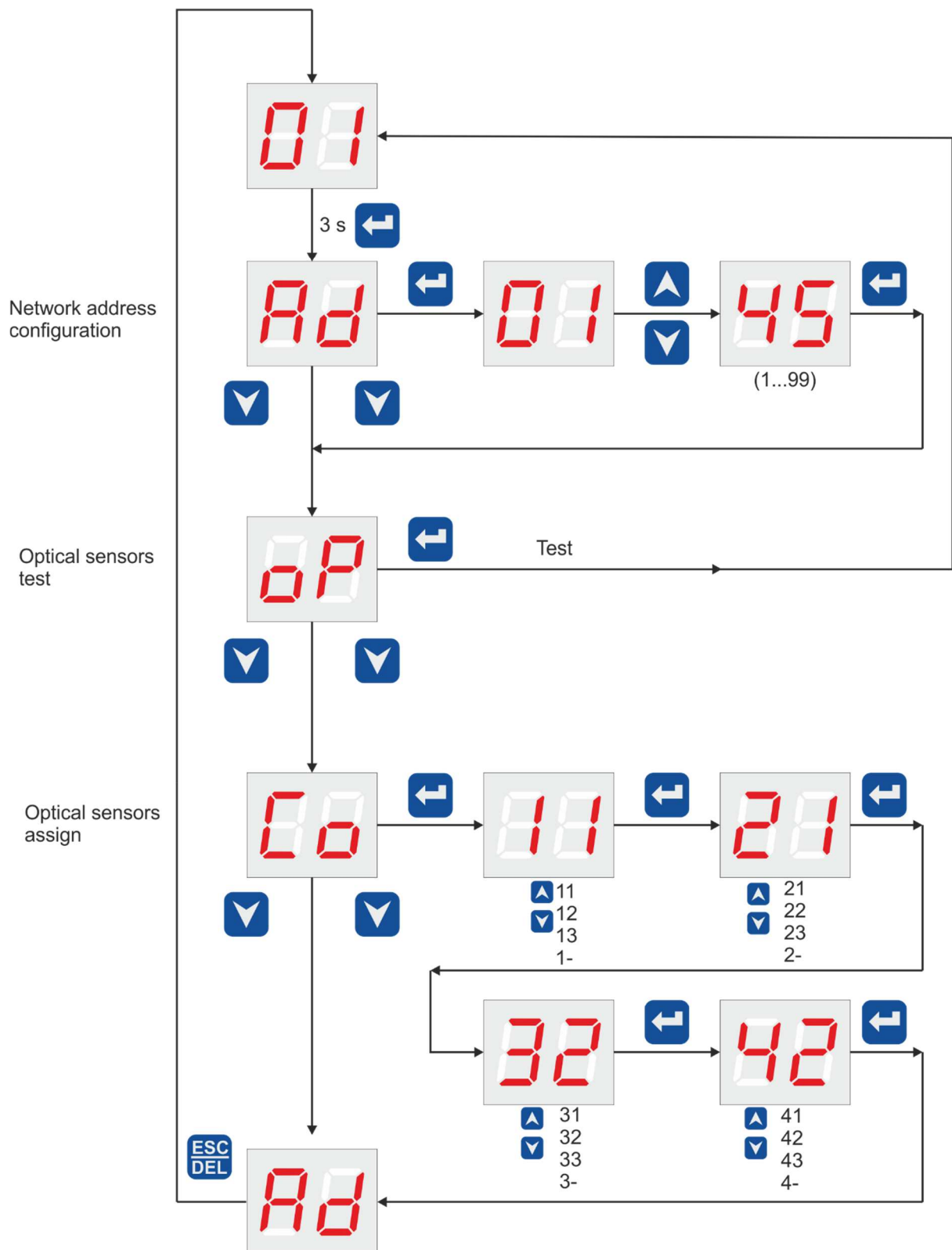


Fig. 23 “Configuration” mode.

The following parameters can be set in the configuration mode:



bay unit network address (ranged 1....99)



association of the protected zones with the corresponding detectors.

There are 3 available options:



detector no. 2 configured to work in zone 1,



detector no. 2 configured to work in zone 2,



detector no. 2 configured to work in zone 3,



detector no. 2 off.

From the level of this menu one can run optical detectors test. The procedure is described in details in section 11.6.

11.4. Error messages

In case when a bay unit will detect wrong operation of the device error number will be shown on the display.

„E1”



no communication with the central unit. The bay unit works in “single criterion” mode.

A tripping signal is generated in case of an optical module activation (U< module activation may not checked). Tripping is only possible in zone 2 and in zone 1 (isolated operation).

„E2”



permanent activation of the optical module (activation of one of the optical detectors for longer than 5 s) The protection does not detect any voltage drop. The detection channel that has been activated permanently is now set “off”. If the cause of activation disappears, the device will return to its normal “ready” status and “ERROR” LED will stop lighting.

„E3



a bay unit has its network address configured incorrectly. A physical connection through CAN interface is correct. It is necessary to register this bay unit in the central unit. “ERROR” LED is not lighted.

„E4”



A bay unit does not have either a network address or a serial number assigned. The “ERROR” LED is not lighted.

„E5”



optical system test result is negative. “ERROR” LED is not lighted.

A detection of an error is signaled by the central unit as well. The “ERROR” LED is lighted, signaling relay contacts F8, F9 JC are closed. Detailed information about the error is available on the page 6) ALARMS of the unit control panel.

11.5. „Tripping” mode

In case when in a protected zone of the switchgear the fault arc has appeared, the protection ZŁ-4A will generate tripping signals to the circuit breakers, according to the established regime. On the front panel of JP “TRIPPING” LED is lighted and information in which protected zone the arc fault has been detected is displayed on the LCD display.

In case when a voltage drop or a voltage fall has appeared on the busbars of the switchgear, the information „UL” will be displayed. The messages are displayed cyclically by blinking light (Fig. 24 and Fig. 25).

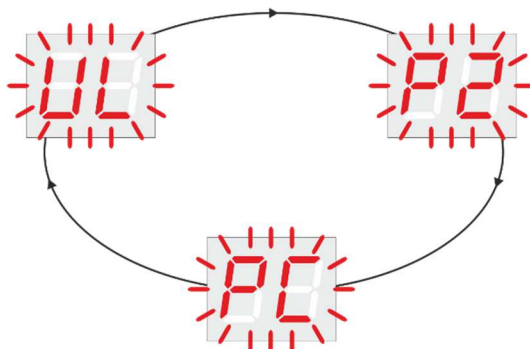


Fig. 24 Messages on the bay unit display („UL” – U< module active, activation after a detection of an arc fault in zone no. 2, information sent to JC).

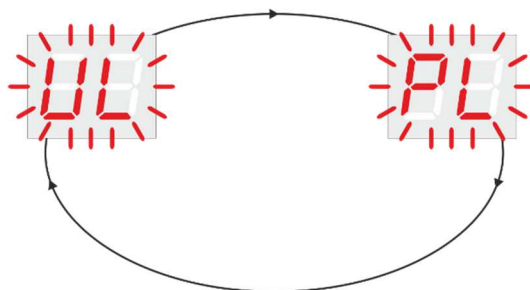


Fig. 25 Messages on the bay unit display in case of a detection of an arc fault in zone 1 in another bay unit (JP has generated the tripping signal after receiving a message about the arc fault from CAN).

Messages displayed on the front panel of a bay unit:

tripping, JP has detected the arc fault in zone 1,

tripping, JP has detected the arc fault in zone 2,

tripping, JP has detected the arc fault in zone 3,

JP has sent information on detection of an arc fault (in any zone),

tripping (JP has received information on detection of a fault in zone 1 and JP has generated a tripping signal after the arc fault detection),

there has been a measurement voltage drop or a fall detected (a respective message is displayed even in case of lack of communication with JC, JPs change their mode into “single criterion” mode).

Deleting “TRIPPING” is realized by pressing  button on the front panel of a bay unit for longer than 3s. The tripping of a bay unit's executive relay is deleted. Deletion of activation or tripping of all elements of the protection system is realized by pressing  button on the front panel of a central unit for longer than 3s.

Information about the protection system tripping is signalized on the front panel and also by closing the contact of the signaling relay (contacts F5, F6 are closed) of JC (the default configuration). Detailed information is available on the page 5) TRIPPING in control panel.

11.6. Optical detectors test

From the level of the configuring menu of the bay unit it is possible to run a test of the optical detectors of the given bay unit. In order to perform such test one needs to press the button  as soon as the following symbol  appears on the screen of the bay unit panel. The results of the test are visible on the bay unit panel for 30 s and until being deleted on the page 8) OPTICAL SEN. TEST of the central unit operating panel. The way the results are presented is shown in Fig. 26.

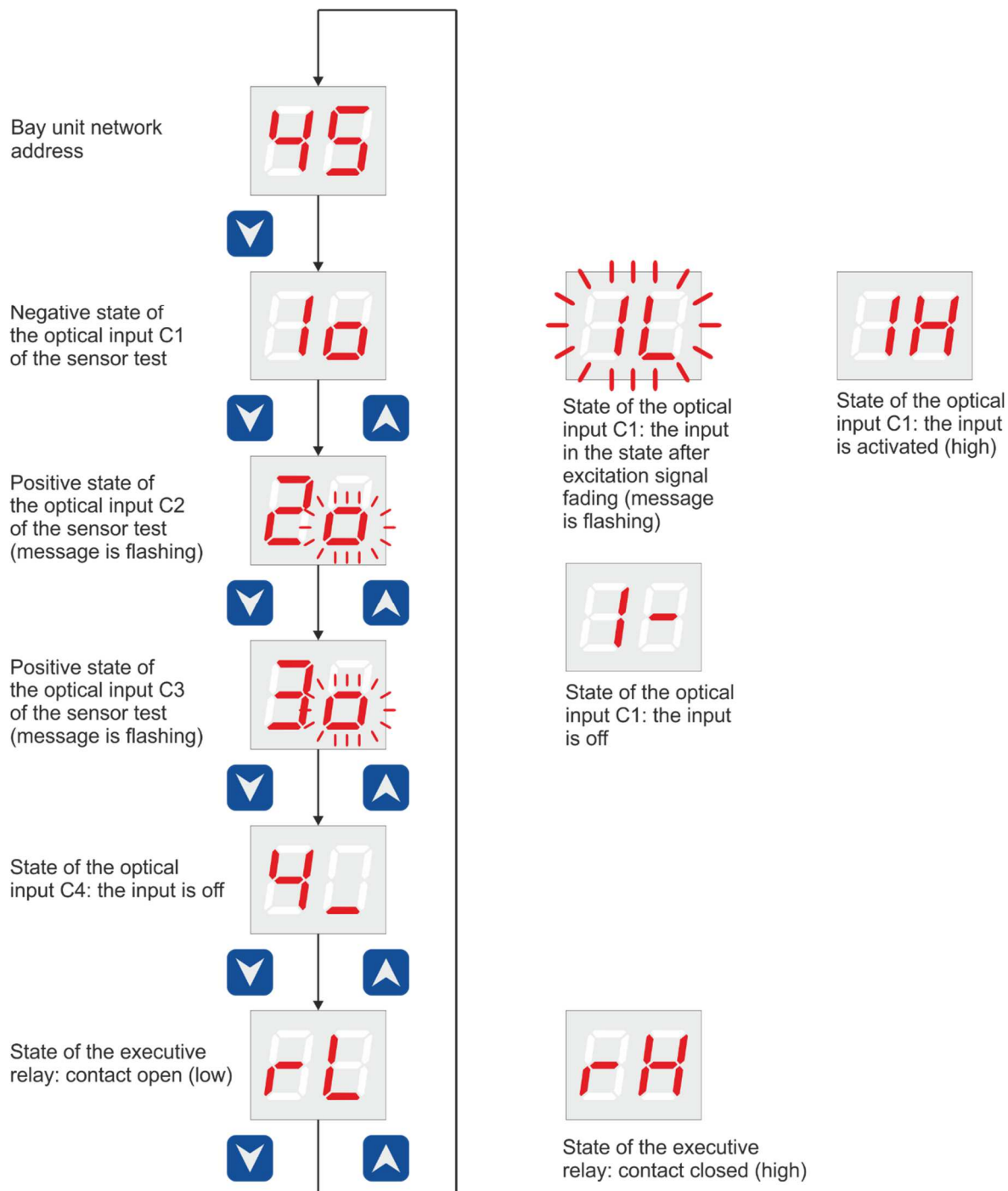


Fig. 26 Presentation of the optical detectors test results.

After detection of the optical system fault the error message **ES** is displayed on the bay unit panel. The error message is viewed until being deleted by pressing button **ESC** or results of the next test run are positive.

12. Using of ZŁ-4A JW control panel

12.1. Information on software version

Immediately after power supply connecting all the LED's and all the segments of the display are illuminated. After a few seconds an actual software version number will be displayed (Fig. 18).



Fig. 27 Actual software version.

Next the executive unit will revert to "ready" status and its network address is visible on the display (under the condition that it has been configured).



Fig. 28 Message displayed for a executive unit without a network address.

In case when a executive unit does not have a configured network address "--" symbol will be displayed. Standard setting is number r1.



Fig. 29 Information displayed if a bay unit does have a configured network address.

12.2. "Ready" status

"Ready" is the basic mode of ZŁ-4A JW. In this mode green LED "POWER SUPPLY" is lighted on the operating panel. Network address is shown on the display. The executive units does not shown on the front panels information about the voltage module "U<".

12.3. Executive unit configuration

In order to enter into the “configuration” mode press  button for 3 s. After that the configuration menu will be displayed (see Fig. 30)

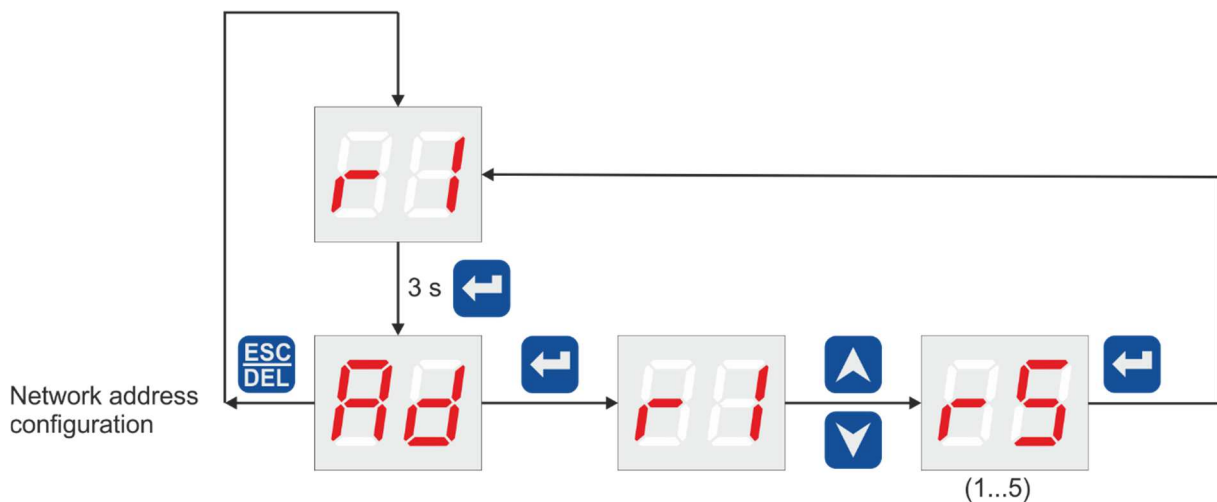


Fig. 30 “Configuration” mode.

The following parameters can be set in the configuration mode:

 executive unit network address (ranged 1....5).

12.4. Error messages

In case when a executive unit will detect wrong operation of the device error number will be shown on the display.

„E1”

 no communication with the central unit. The executive unit will not generated a tripping signal.

„E2”

 not applicable.

„E3

 an executive unit has its network address configured incorrectly. A physical connection through CAN interface is correct. It is necessary to register this executive unit in the central unit. “ERROR” LED is not lighted.

„E4”

 an executive unit does not have either a network address or a serial number assigned. The “ERROR” LED is not lighted.

„E5”



not applicable.

A detection of an error is signalized by the central unit as well. The “ERROR” LED is lighted, signaling relay contacts F8, F9 JC are closed. Detailed information about the error is available on the page 6) ALARMS of the unit control panel.

12.5. „Tripping” mode

In case when in a protected zone of the switchgear the fault arc has appeared, the protection ZŁ-4A will generate tripping signals to the circuit breakers, according to the established regime. On the front panel of JW “TRIPPING” LED is lighted. Information on the activation of the JW unit is also signaled by closing the contact of the signaling relay (the contacts B1, B2 are closed).

Deleting “TRIPPING” is realized by pressing  button on the front panel of an executive unit for longer than 3s. The tripping of an executive unit's executive and signaling relay is deleted. Deletion of activation or tripping of all elements of the protection system is realized by pressing  button on the front panel of a central unit for longer than 3s. Information about the protection system tripping is signalized on the front panel and also by closing the contact of the signaling relay (contacts F5, F6 are closed) of JC (the default configuration). Detailed information is available on the page 5) TRIPPING in control panel.

13. Using of central unit ZŁ-4A JC control panel

The central unit of the protection ZŁ-4A is equipped with a few optical signal LEDs and an LCD display. Messages, which are important for a user, are presented by lighting LEDs. This allows one to verify the state of the protection very quickly. In case of any abnormality it is possible to take immediate actions. Detailed information is showed on LCD display. In case of detecting any problems with the protection the signaling relay is tripped (the contacts F8, F9 are closed). Below it is presented how to use the control panel of ZŁ-4A JC and some typical messages generated on the front panel of the central unit are shown.

13.1. LCD display startup screen

After supplying the central unit the company logo is shown on LCD display and later it is replaced with information about JC serial number and a software version.



Fig. 31 Info screen.

„S/N: JC-00-123” – JC serial number

„Version 2.4” – software version

„Build 1” – compilation number

13.2. Control panel menu structure

The control panel menu has a tree structure with branches. The name of the current menu (or the submenu) with its number and the list of available submenus are presented in the headline on the display (see Fig. 32). A submenu can have a variable providing information about present status of the protection system. This parameter is then presented in the submenu's headline after symbol $\therefore$. Scrolling to main pages of the menu is selected by  button. A submenu selection is done by  button (Fig. 33). A currently selected submenu is denoted by the symbol . Entering the submenu is executed after pressing  button.

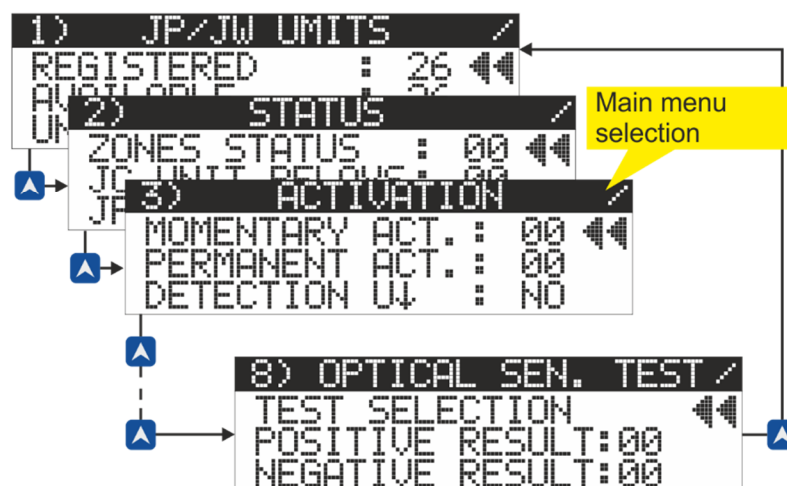
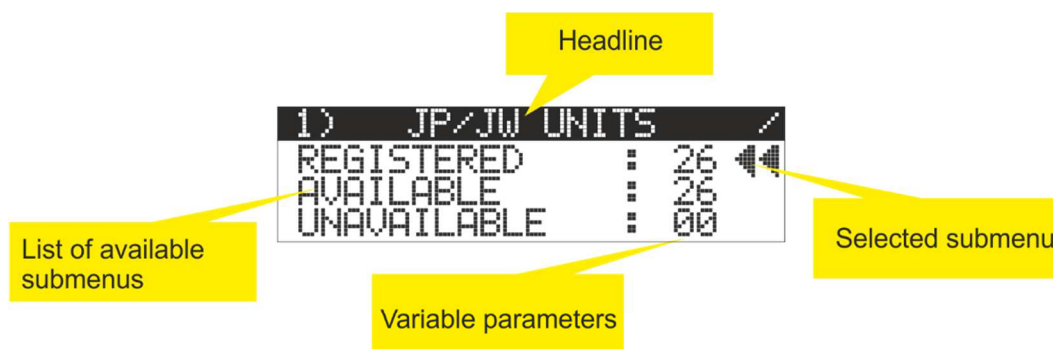


Fig. 32 Scrolling between main menus (pages).

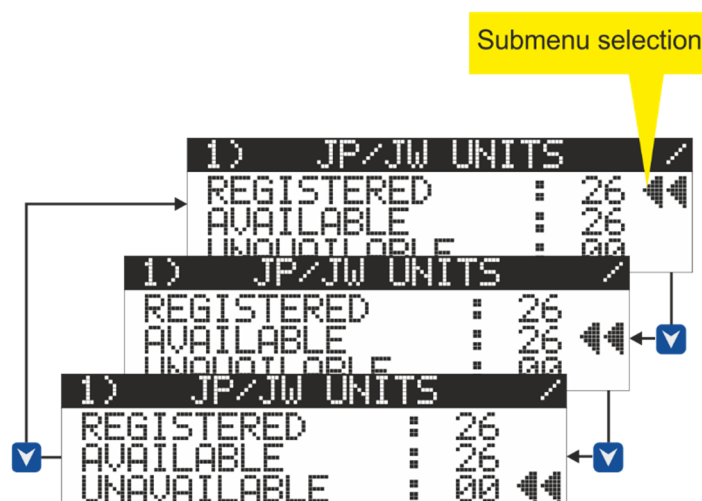


Fig. 33 Submenu selection.

13.3. Menu (pages) review

13.3.1. Page 1) JP/JW UNITS.

On the page 1) JP/JW UNITS there is information presented on the bay (JP) and executive (JW) units registered by the user in JC.

The respective submenus give the following information:

- “REGISTERED” – amount of the registered units,
- “AVAILABLE” – amount of units JC can communicate with,
- “UNAVAILABLE” – amount of units, which are registered, but JC cannot communicate with them.

When the protection is configured correctly, the amounts of available and registered units should be equal. In case of lack of communication with whichever unit the signal about error is generated. The network address of an unavailable unit is displayed in submenu “UNAVAILABLE”.

After entering the submenu the list of JP/JW network addresses of the selected criteria (specified by the submenu name) is presented. A user selects and accepts the network address of JP/JW by pressing  button. Then the user has access to the detailed information about the specified JP/JW.

Information about a certain JP/JW is available in different menus after entering its network address. It is possible to view various parameters of JP/JW submenu without another network address entering from the overriding menu. In this case is necessary to press  button. The specified submenu is switched between units.

JP has the following parameters, which are grouped in six submenus:

Submenu “REPORT”

- ADDRESS – JP network address,
- S/N – serial number,
- FIRMWARE – firmware version;

Submenu “STATUS”

- REGISTERED – informs whether the specified unit is registered,
- AVAILABLE IN NETWORK – informs whether JC can communicate with JP,
- ADDRESS ERROR – informs whether there is an address conflict in the network;

Submenu “TRIPPING”

- IN ZONE S1 – it informs whether a unit has generated a tripping signal after an arc fault detection in zone 1,
- IN ZONE S2 – it informs whether a unit has generated a tripping signal after an arc fault detection in zone 2,
- IN ZONE S3 – it informs whether a unit has generated a tripping signal after an arc fault detection in zone 3;

Submenu “LOG. STATE”

SENSORS – it shows current status of JP optical inputs, optical inputs are denoted by numbers from 1 to 4. The logical status of the specified optical input is showed below the number. There are the following optical input statuses possible:

“0–“ the optical input is inactivated,

“0P” there has been a temporary activation of the optical input, however the current status of the optical input is inactivated,

“1P” the optical input has been activated,

“1U” the optical input has been permanently activated (>5s);

RELAY – it presents the current status of JP executive relay. There are the following executive relay statuses possible:

„L” inactivated relay, the contact of the relay is opened,

„H” activated relay, the contact of the relay is closed;

Submenu “SETTINGS”

SENSORS – it shows the current configuration of the optical inputs. The optical inputs are denoted by numbers from 1 to 4. The present configuration of the specified optical input is showed below the number. There are the following optical input configurations possible:

“S1” optical input is assigned to zone 1,

“S2” optical input is assigned to zone 2,

“S3” optical input is assigned to zone 3,

“—“ optical input is off.

Submenu “TEST RESULT”

SENSORS – it shows the current test result of the optical system. The optical inputs are denoted by numbers from 1 to 4. The present test result of the given optical system is showed below the number. There are the following optical system test results possible:

“OK” optical system test result positive,

“ER” optical system test result negative,

“—“ optical input is off.

Information about JP is read by JC directly from the bay units JP. It is impossible to present some information about inaccessible units. The way to view information about JP is showed in Fig. 34.

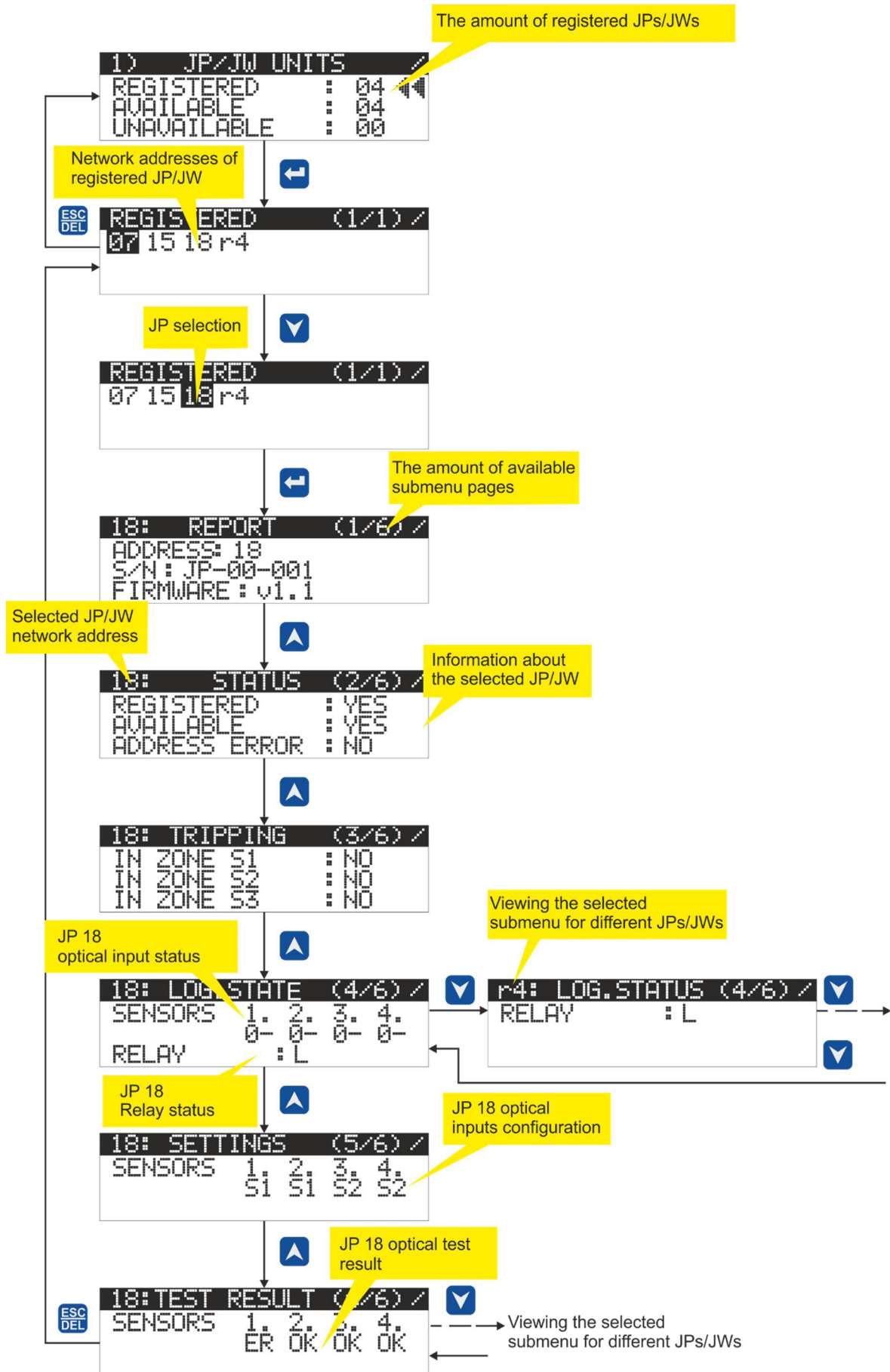


Fig. 34 Viewing available information about JP.

JW has the following parameters, which are grouped in six submenus:

Submenu “REPORT”

ADDRESS – JW network address,
S/N – serial number,
FIRMWARE – firmware version;

Submenu “STATUS”

REGISTERED – informs whether the specified unit is registered,
AVAILABLE IN NETWORK – informs whether JC can communicate with JW,
ADDRESS ERROR – informs whether there is an address conflict in the network;

Submenu “TRIPPING”

NOT APPLICABLE

Submenu “LOG. STATE”

RELAY – it presents the current status of JW executive relay. There are the following executive relay statuses possible:

„L” inactivated relay, the contact of the relay is opened,
„H” activated relay, the contact of the relay is closed;

Submenu “SETTINGS”

NOT APPLICABLE

Submenu “TEST RESULT”

NOT APPLICABLE

Information about JP is read by JC directly from the bay units JP. It is impossible to present some information about inaccessible units. The way to view information about JP is showed in Fig. 35.

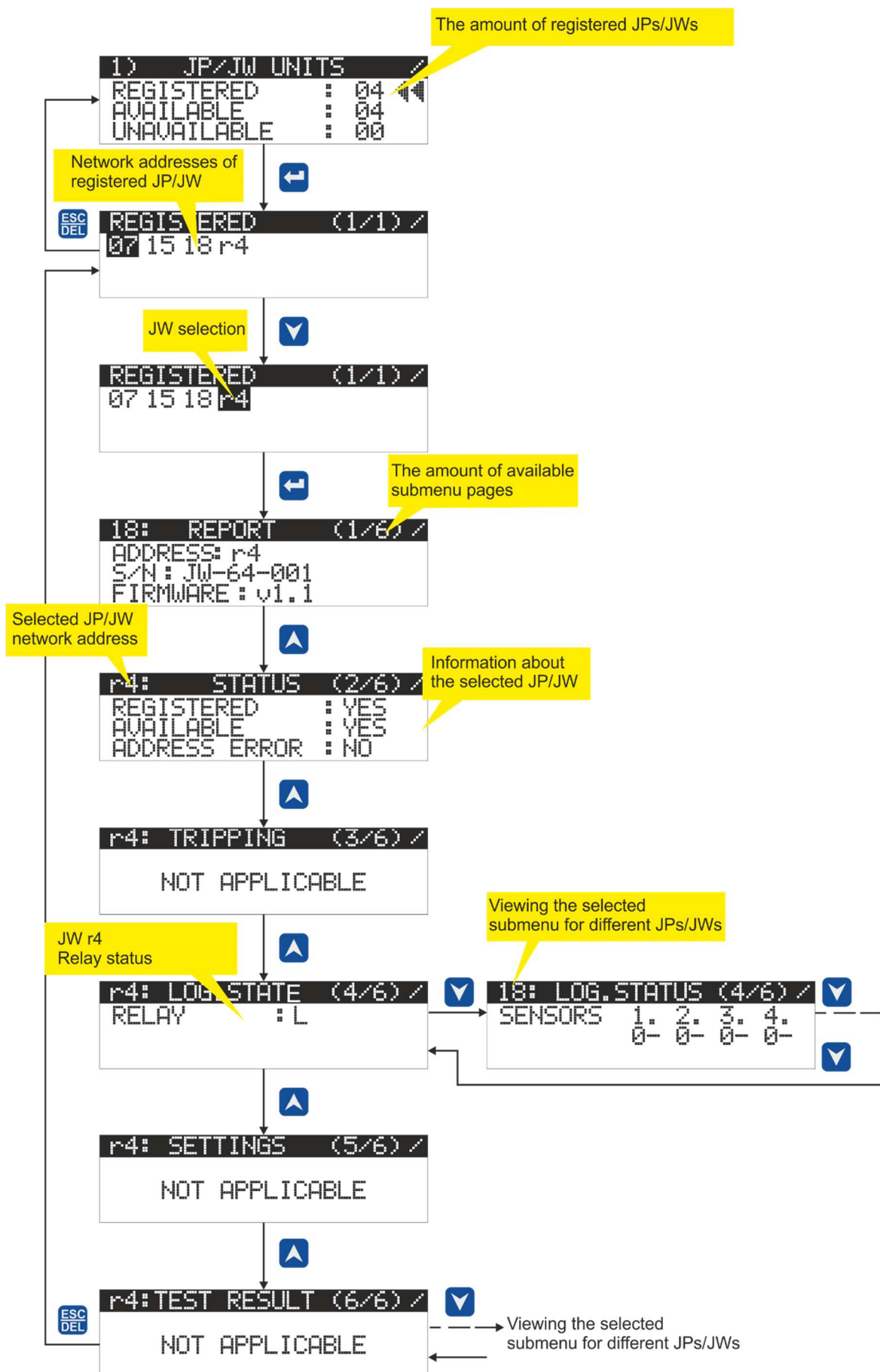


Fig. 35 Viewing available information about JW.

13.3.2. Page 2) STATUS

Information about current status of the protection is displayed on this page

The following submenus are available:

Submenu “ZONES STATUS”

After selecting this submenu by pressing  button the user receives information about the amount of JP which have the optical detector configured for working in the specified zones.

When the submenu is selected by pressing  button it is possible to obtain information  about network addresses of the units with the optical detectors assigned to the specified zone. When the JP network address is selected (by pressing  button), it is possible to obtain detailed information about the present status and configuration of JP. Selecting the next subpages takes place by pressing  button. The next JP is selected by pressing the  button.

ZONE S1 : 00 – it shows information about the amount of the units with the optical detector assigned to zone 1,

ZONE S2 : 00 – it shows information about the amount of the units with the optical detector assigned to zone 2,

ZONE S3 : 00 – it shows information about the amount of the units with the optical detector assigned to zone 3.

Submenu “JC UNIT RELAYS : 00”

This submenu shows the amount of the JC activated executive relays. After selecting this submenu by pressing  button the user receives detailed information about a status of the JC executive relays.

“Z: JC UNIT RELAYS”

The executive relays are denoted by symbols from P1 to P6. The present relay status is displayed below the relay name. The following executive relays statuses are possible:

“0” relay contact is opened,

“1” relay contact is closed.

In case when the relay is activated, i.e. its status is “1”, the user has an opportunity to get information about which JP units have generated a signal for the relay activation. In order to obtain such information please select relay number (P1-P6) by pressing  button and then confirm your choice by pressing  button. Next, the page “RELAY Px” (where “x” denotes the relay number) with the list of JP network addresses will be shown the LCD display.

Directly from the submenu Z: JC UNIT RELAYS the user can get information about the configuration of the specified executive relay by pressing  button.

N: JC RELAYS

The executive relays are denoted by symbols from P1 to P6. The present configuration of a relay is showed below the relay name. The following configurations of the executive relays are possible:

- “S1” – relay contact is closed after an arc fault detection in zone S1,
- “S2” – relay contact is closed after an arc fault detection in zone S2,
- “S3” – relay contact is closed after an arc fault detection in zone S3,
- “S Σ ” – relay contact is closed after an arc fault detection in any zone,
- “U $\downarrow$ ” – relay contact is closed after a voltage drop or a lack of voltage detection,
- “LG” – relay contact is closed according to the logical function created by a user (details about creating logical functions are described in point 13.3.7),
- “--” – relay is switched off.

Submenu “JP/JW RELAYS : 00”

This submenu shows the amount of JP and JW with the activated executive relays. After selecting this submenu the user obtains information about the JP and JW network address with the executive relays in “H” status (closed).

Using the submenu 2) STATUS is shown in Fig. 36.

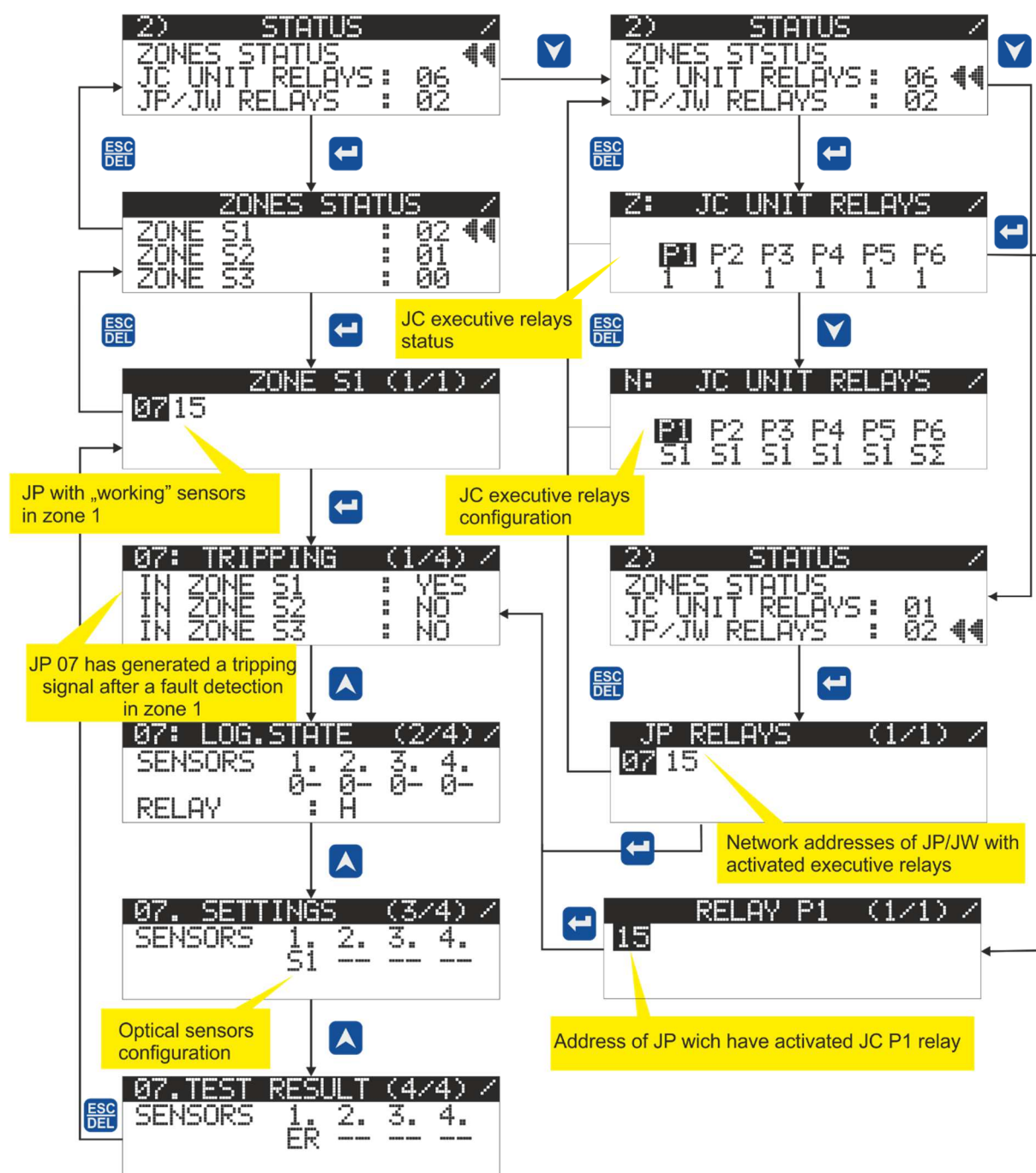


Fig. 36 Page 2) STATUS using.

13.3.3. Page 3) ACTIVATION

Information about activation of bay units optical inputs and information about activation of the voltage module “U<” are presented on that page.

The following submenus are available on that page:

Submenu “MOMENTARY ACT.”

This submenu displays information about the amount of bay units, which optical input has been temporarily activated.

Submenu “PERMANENT ACT.”

This submenu displays information about the amount of bay units, which optical input has been permanently activated.

Submenu “DETECTION U↓”

This submenu shows whether the voltage module “U<” has been activated.

After entering  the submenu (momentary or permanent act.) the list of JP network addresses of the selected criteria, is presented. Users have access to detailed information by selecting a certain JP network address  and after accepting it by pressing  button.

Fig. 37 shows the case when there have been optical modules activated in units with network addresses 07 and 15. Detailed information about JP with network address 07 shows that the optical module No. 1 has been temporarily activated (0P). That optical module works in zone S1. The executing relay of the bay unit is in inactivated status “L”.

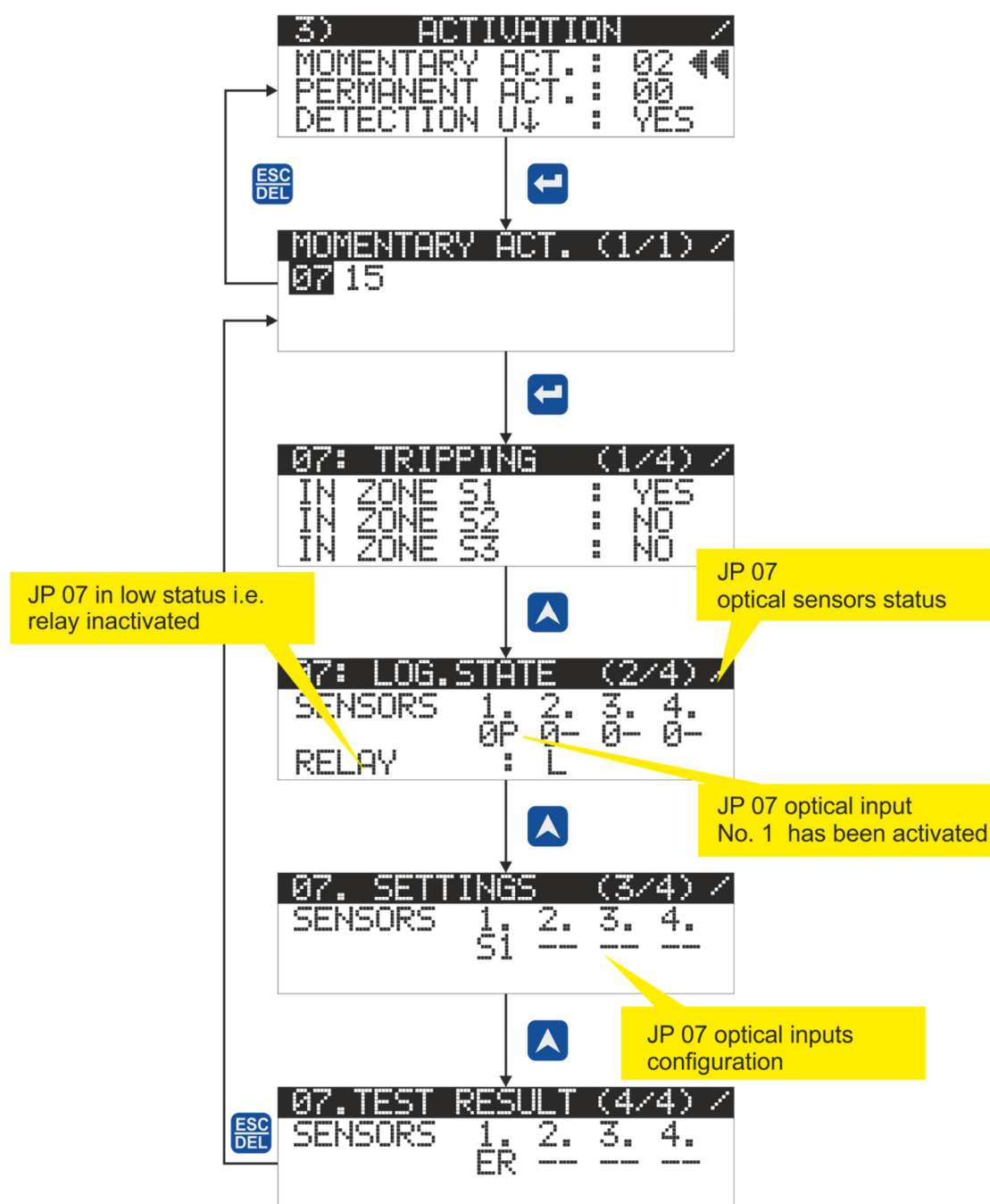


Fig. 37 Analysis of optical module temporary activation.

13.3.4. Page 4) OCCURRENCES

This page shows information about the protection tripping impulses. Information is generated based on alarm messages sent by JP. Information is available until deleting by  button.

There are the following submenus on this page:

Submenu "IN ZONE S1"

This submenu displays information about the amount of units which have generated a tripping signal in zone S1.

Submenu "IN ZONE S2"

This submenu displays information about the amount of units which have generated a tripping signal in zone S2.

Submenu "IN ZONE S3"

This submenu displays information about the amount of units which have generated a tripping signal in zone S3.

After entering the menu, similarly to other main pages, there is the list of JP network addresses of the selected criteria. Users have access to detailed information by selecting the JP network address  and accepting it by pressing  button.

In case of lack of communication between JC and JP:

- If an occurrence happened before the network failure, the network address of the unavailable JP is marked with "!". Detailed information about the JP is inaccessible,
- If the network failure happened before an occurrence, information about tripping signal is unavailable.

13.3.5. Page 5) TRIPPING

On this page information about tripping signals generated by the protection is presented. Information can be read from JP directly.

There are the following submenus on this page:

Submenu "IN ZONE S1"

This submenu displays information about the amount of units, which have generated a tripping signal in zone S1. After entering the submenu the network address of JP, which has detected an arc fault in zone S1, is marked by sign "**".

Submenu "IN ZONE S2"

This submenu displays information about the amount of units, which have generated a tripping signal in zone S2.

Submenu "IN ZONE S3"

This submenu displays information about the amount of units, which have generated a tripping signal in zone S3.

After entering the submenu, similarly as it is on other main pages, there is a list of JP network addresses, which are subjected to a specified criterion.

User has an access to detailed information by selecting the JP network address  and confirming it by pressing  button.

In case of loss of communication between JC and JP:

- If an occurrence happened before the network failure, the network address of the unavailable JP is marked with "!". Detailed information about the JP is inaccessible.
- If the network failure happened before an occurrence, information about tripping signal is unavailable.

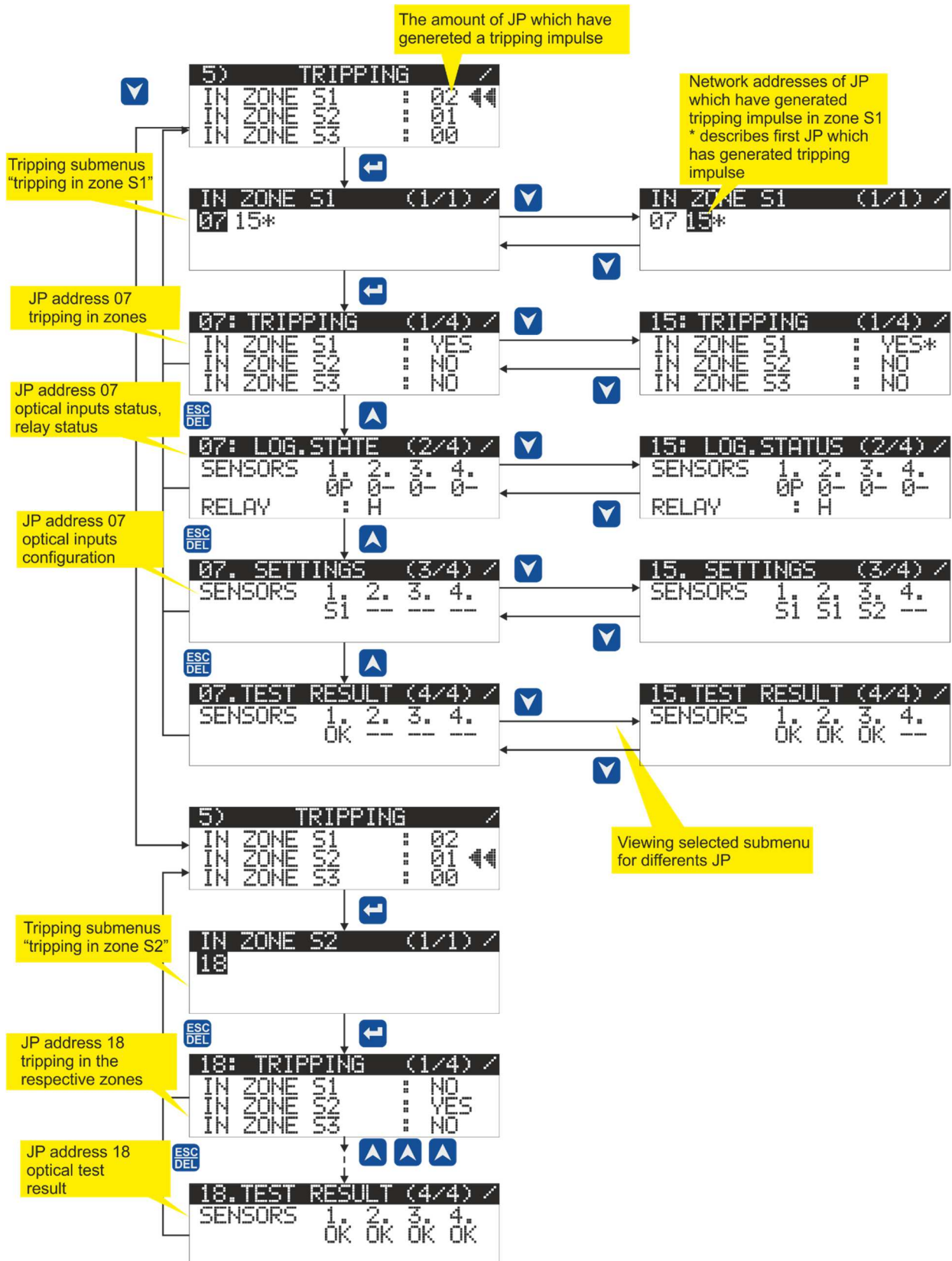


Fig. 38 Analysis of tripping signals which have been generated in zone S1 by JPs with network addresses 07 and 15, and in zone S2 by JP with network address 18.

13.3.6. Page 6) ALARMS

Information about the errors detected during operation of the protection are presented on this page.

Available submenus:

Submenu "UNAVAILABLE"

This submenu informs about the amount of the registered units JC cannot communicate with.

Submenu "PERMANENT ACT."

This submenu displays information about the amount of bay units, which optical inputs have been permanently activated.

In the case of loss of communication between JC and JP, next to the amount of JP, "!" is marked. Detailed information about the JP may be incorrect or unavailable.

Submenu "ADDRESS ERROR"

This menu informs about the amount of units with a network address conflict (change of the JP or JW network address without re-registration, change of the JP or JW network address for an address already existing in the network).

Submenu "OPT. SENSOR FAIL"

This menu informs about the number of units in which optical system error has been detected.

After entering this submenu, there is a list of JP or JW network addresses presented, which follow a selected criterion. User has an access to detailed information by selecting the JP or JW network address  and accepting it by pressing  button. In Fig. 39 a way of localizing a permanently activated optical input is presented.

The bay unit with the network address 07 has a permanently activated optical input No. 3. The input is configured to switch off a circuit-breaker of the outgoing compartment of the bay (zone S2). JP executive relay is in the inactivation status "L" (the contact is opened).

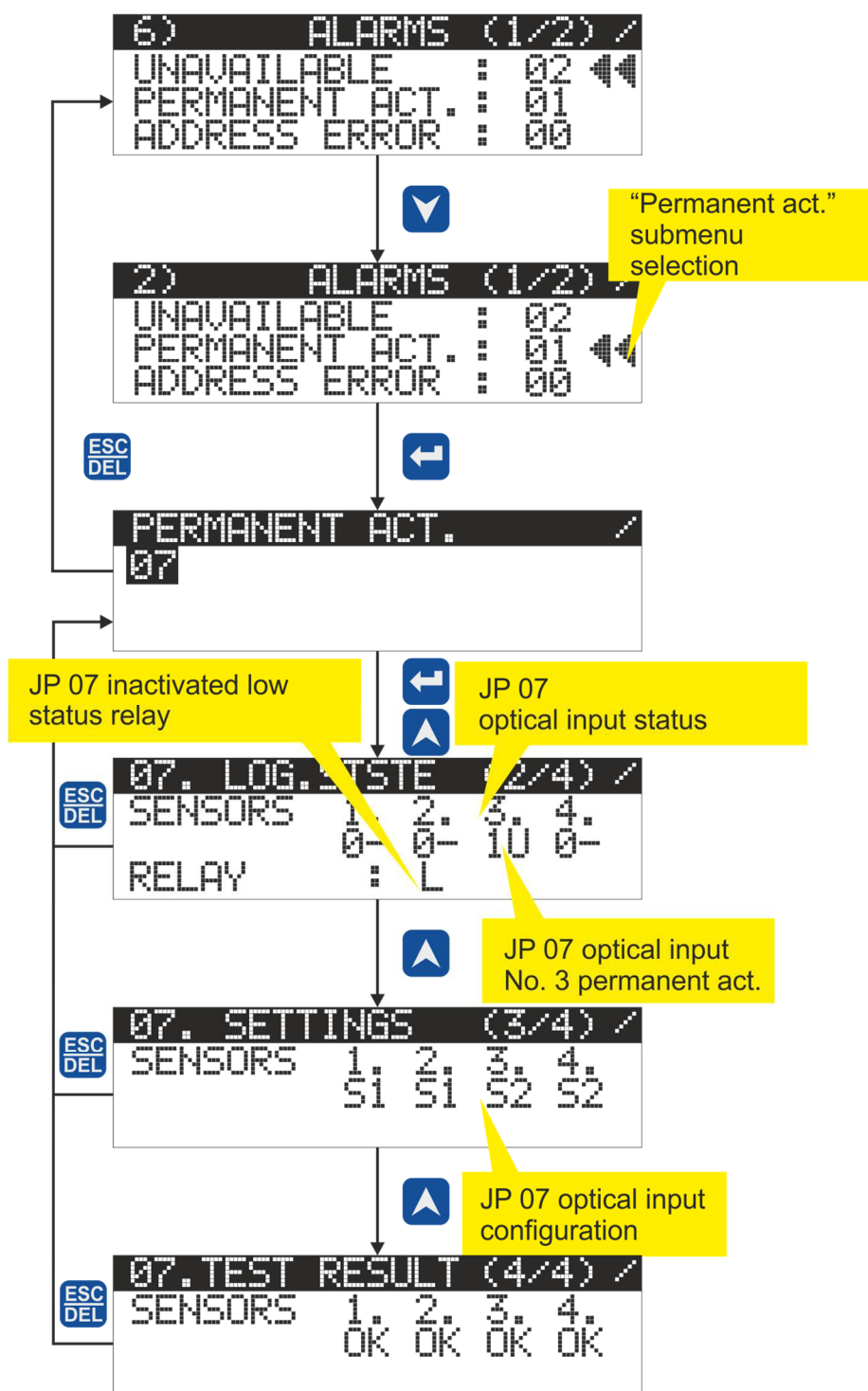


Fig. 39 Location of a permanently activated optical input.

13.3.7. Page 7) CONFIGURATION

Page "CONFIGURATION" allows the user to configure basic elements of the arc fault protection system. By selecting a proper submenu  the user can configure JC executive relays tripping, registration or deletion of JP/JW, or configure the parameters of RS485 protocol (MODBUS).

There are the following submenus on that page:

Submenu "JC UNIT RELAYS"

After selecting this submenu the screen "JC UNIT RELAYS" is displayed. It includes the list of available JC executive relays which are denoted by symbols from P1 to P6. Selecting a relay is done by pressing  button. The function which determines the relay tripping is chosen by  button.

There are the following functions describing the tripping of relays available:

- "S1" – contact relay is closed after an arc fault detection in zone S1,
- "S2" – contact relay is closed after an arc fault detection in zone S2,
- "S3" – contact relay is closed after an arc fault detection in zone S3,
- "S Σ " – contact relay is closed after an arc fault detection in any zone,
- "U $\downarrow$ " – contact relay is closed after a voltage drop or lack of voltage detection,
- "LG" – contact relay is closed according to the recorded logical function,
- "--" – relay is switched off.

Selection of a function that describes the tripping of a relay is showed in Fig. 40.

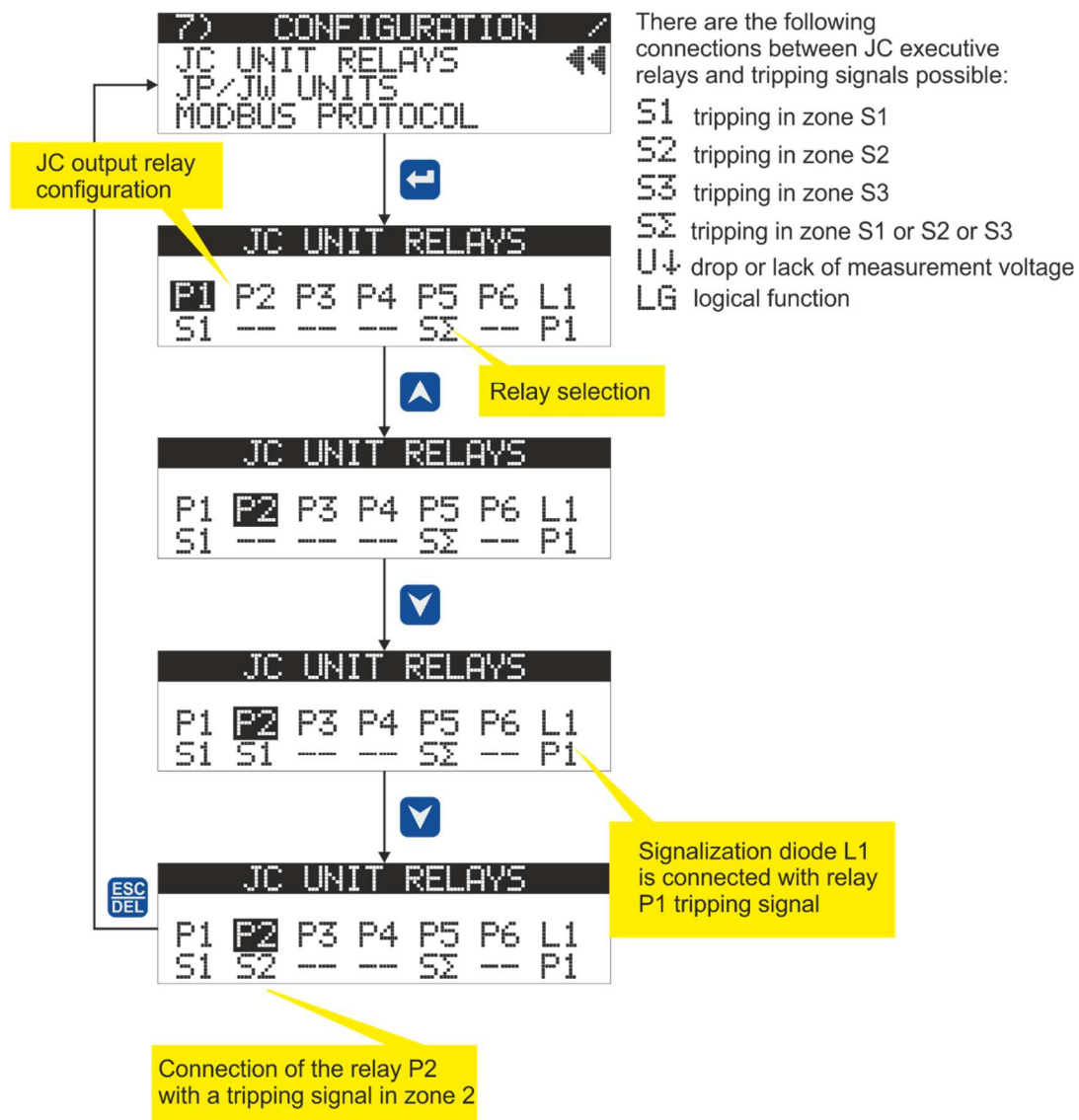


Fig. 40 JC executive relays configuration.

In case when a user subjects the relays tripping to a logical function “LG” it is necessary to enable the realization of this function. The syntax describing the logical function is based on selection of the specified JPs detector with a correct way of tripping. Then, the function created by the user is a logical sum of the selected JPs detectors in particular zones. The idea of creating a function “LG” is presented in Fig. 41.

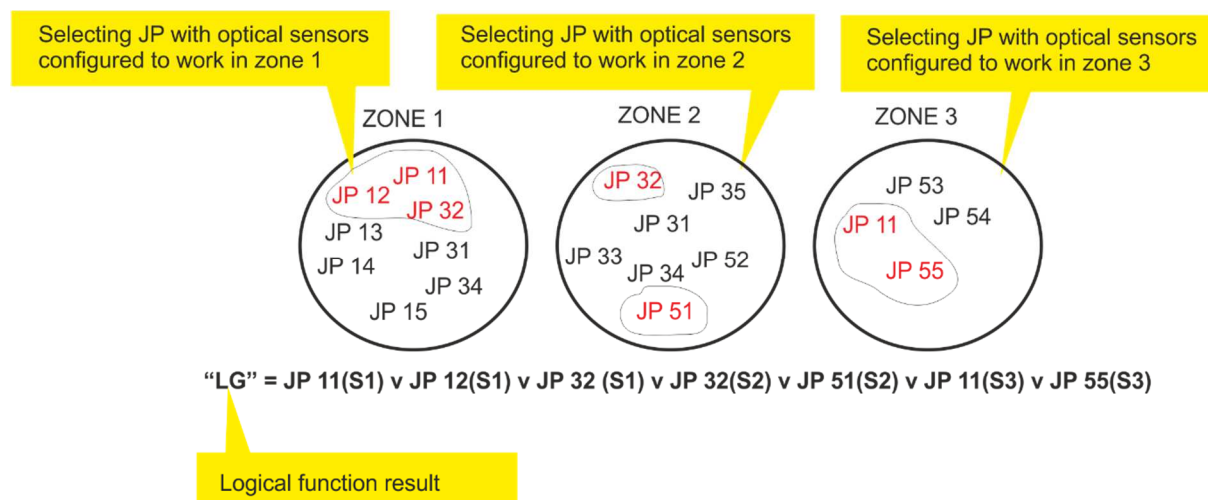


Fig. 41 Way of creating a logical function "LG" which resolves JC executive relays tripping.

Access to the logical function configuration is realized by pressing button, selecting "LG" option and confirming it by pressing button.

Further approach to configuration is showed in Fig. 42.

Attention!

In case of a change of the JP network address or deletion of the JP from the network, it is necessary to configure the logical function "LG" again. Network addresses of unavailable JP are denoted by symbol "*" (e.g. the units which have their network addresses changed).

The default configuration of JC executive relays:

P1-P5 - connected with zone S1 (executive contact relay is closed after an arc fault detection in zone S1),

P6-S Σ - connected with zones S1, S2, S3 (executive contact relay is closed after an arc fault detection in any zone).

JC is equipped with a configurable signal diode (RELAY EXE). Illumination of the LED can be connected with JC executive relays tripping.

There are the following settings available:

"P1"... "P6" – LED is lighted, when one of the relays P1...P6 is closed,

"P Σ " – LED is lighted, when any relay is closed.

Configuration is available in submenu "JC UNIT RELAYS". Element denoted by symbol "L1" should be selected by button. Connection with one of the relays or LED signalization of any relay tripping should be selected by button.

In Fig. 42 illumination of the signalization diode is related to the tripping of the JC executive relay, P1.

Default configuration of signalization diode "RELAY EXE":

L1 - "PΣ" – LED signalizes that any relay is closed.

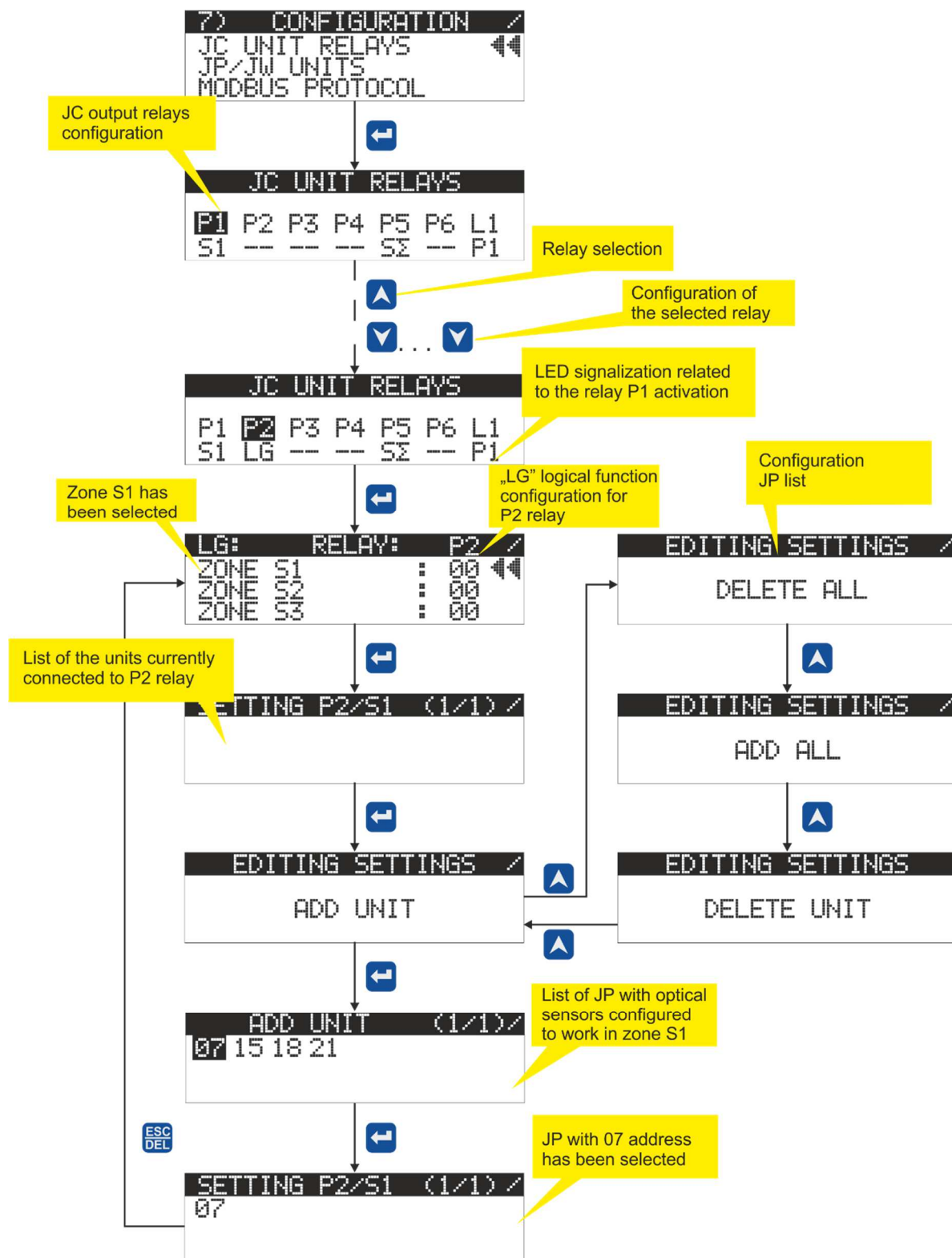


Fig. 42 Configuration of the logical function "LG". Contact of relay P2 is closed if JC 07 optical detector has been activated and had been configured before to work in zone S1.

Submenu “JP/JW UNITS”

After entering this submenu it is possible to register JP/JW in the system or delete the unit from the system.

“ADD UNIT” – it allows one to add a unit to the system (registering). The unit is added by selecting the network address, which has been configured by the user, from the list. The choice is accepted by pressing  button (Fig. 43).

“DELETE UNIT” – it allows one to delete a unit from the system (unregistering). The unit is deleted from the system by selecting the network address from the displayed list. The choice is accepted by pressing  button (Fig. 43).

“SCAN & INSTALL” – after selection of this mode JC automatically searches through the network and registers automatically all bay and executive units with correct network addresses (Fig. 44).

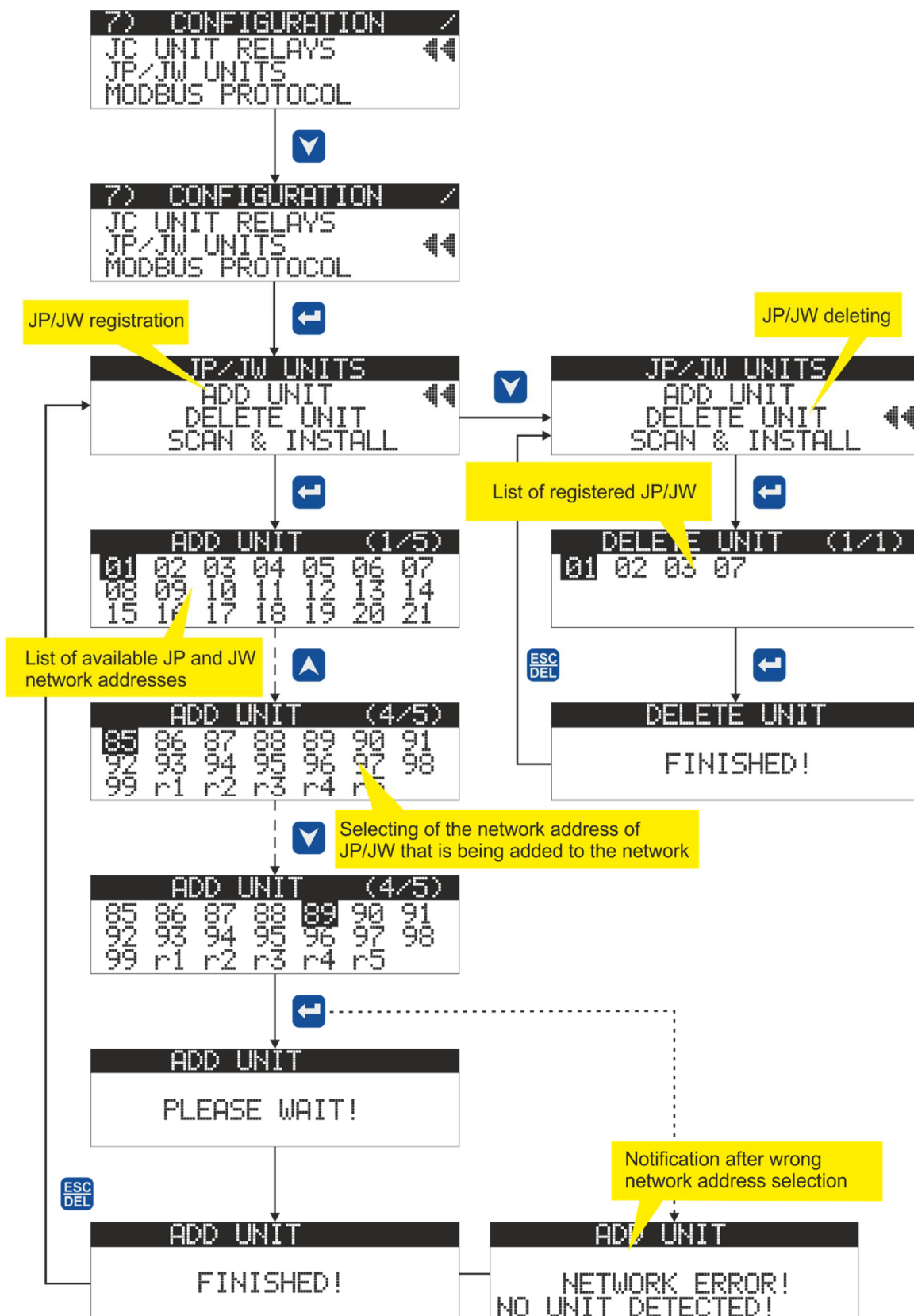


Fig. 43 Adding of bay and executive units to the system and deleting them from the system.

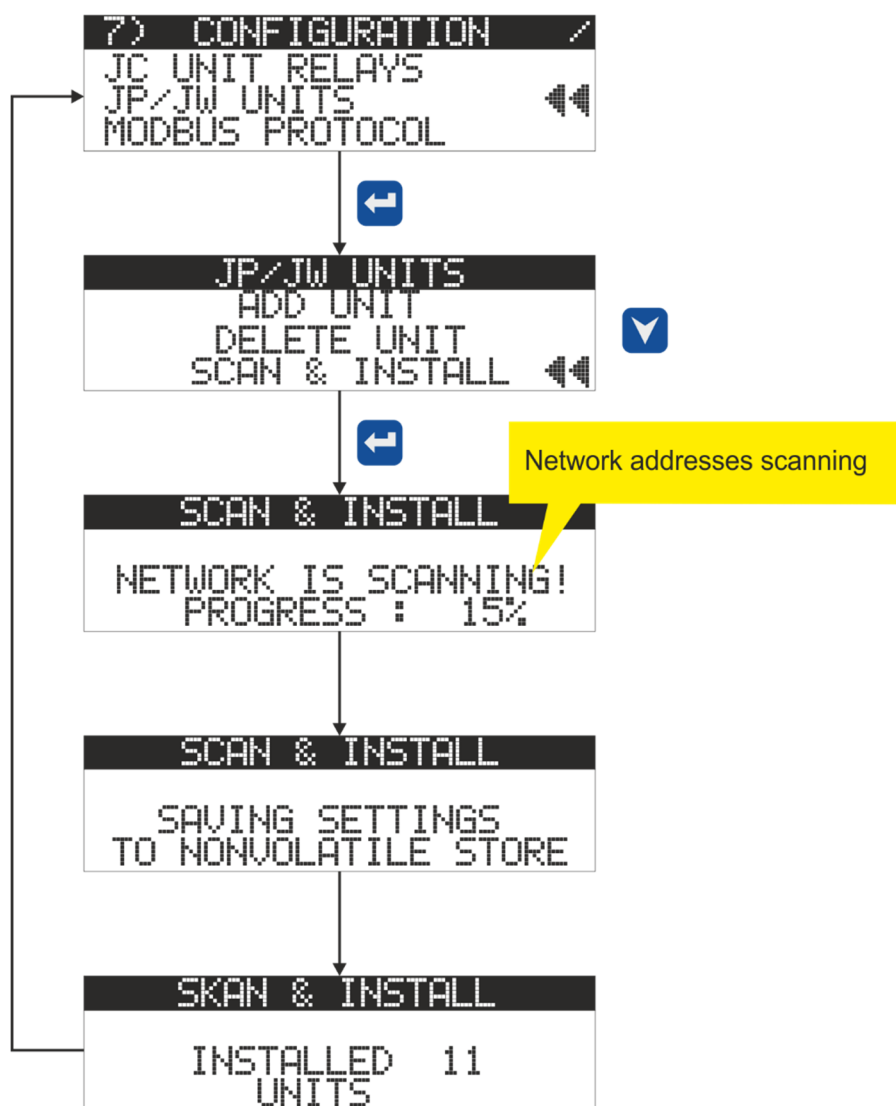


Fig. 44 Automatic unit registration in the system (adding to the system).

Submenu „MODBUS PROTOCOL”

By selecting this submenu the user has a possibility to configure MODBUS network address and to choose the transmission speed for interface RS485 (Fig. 45).

“ADDRESS MODBUS SLAVE” – it allows one to configure a network address in range from 1 to 240.

“TRANSMISSION SPEED” – it allows one to select RS485 interface transmission speed. There are four modes available: 9600 bps, 19200 bps, 38400 bps, 57600 bps.

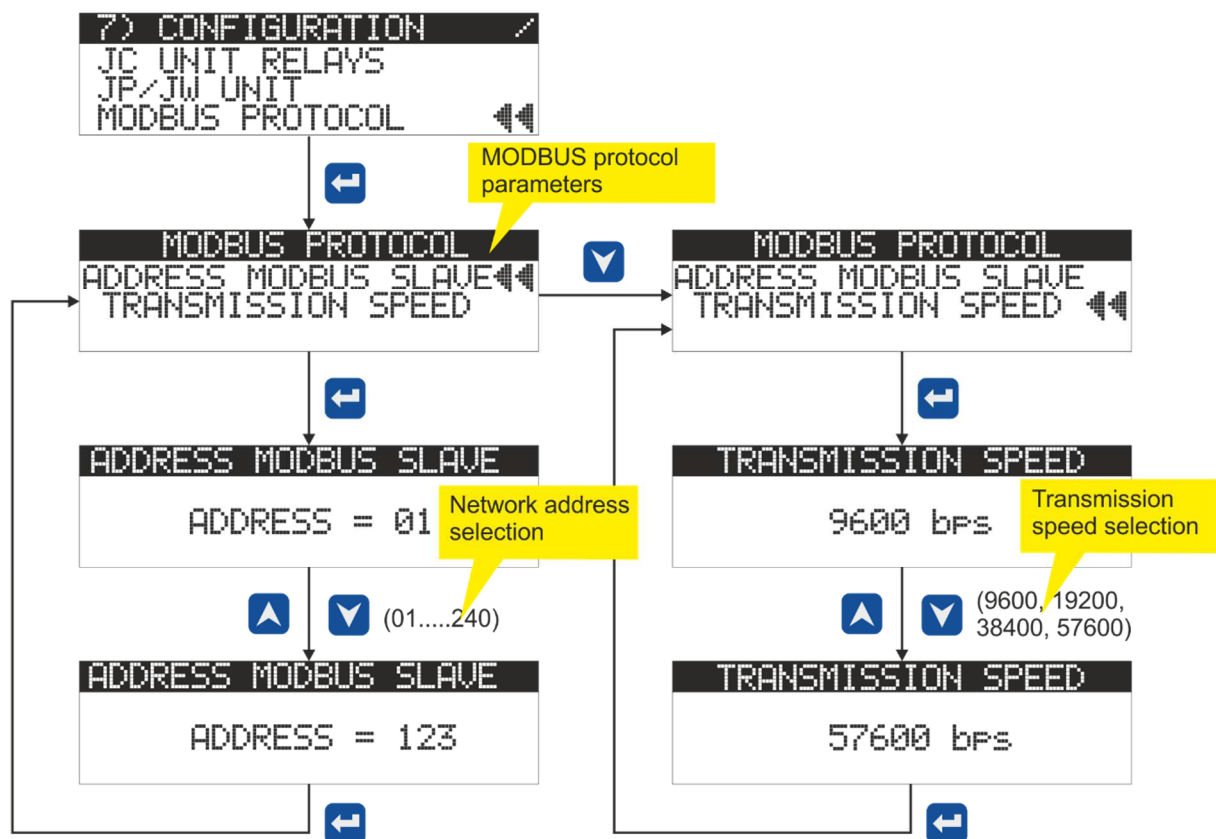


Fig. 45 MODBUS-slave network address configuration and transmission mode selection.

Submenu "JW UNIT RELAYS"

After selecting this submenu the screen "JW UNIT RELAYS" is displayed. It includes the list of available JW which are denoted by symbols from R1 to R5. Selecting an executive unit is done by pressing button. The function which determines the executive unit relay tripping is chosen by button. The functions of the executive units relays tripping are identical to those of the central unit relays. The description of the function can be found in 13.3.7 Submenu "JC UNIT RELAYS".

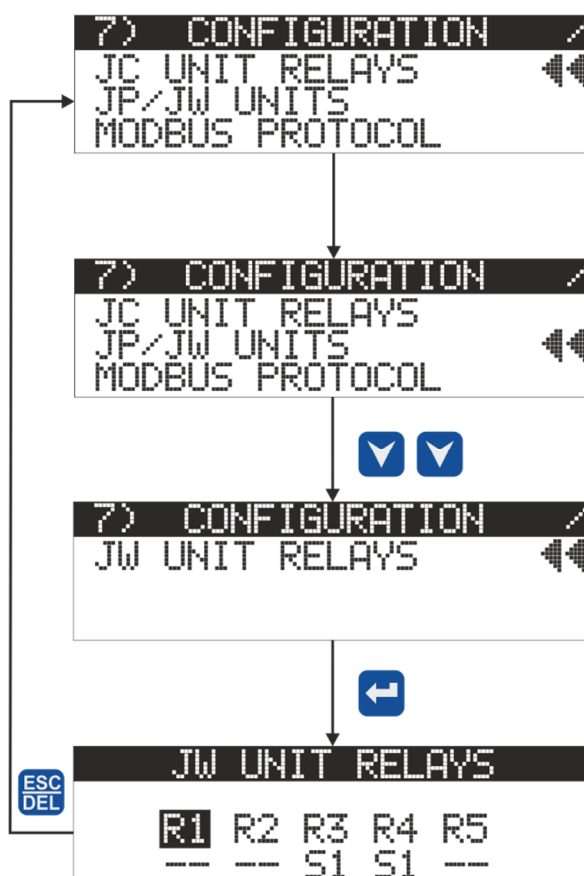


Fig. 46 Selecting the JW unit executive relays configuration.

13.3.8. Page 8) OPTICAL SYSTEM TEST

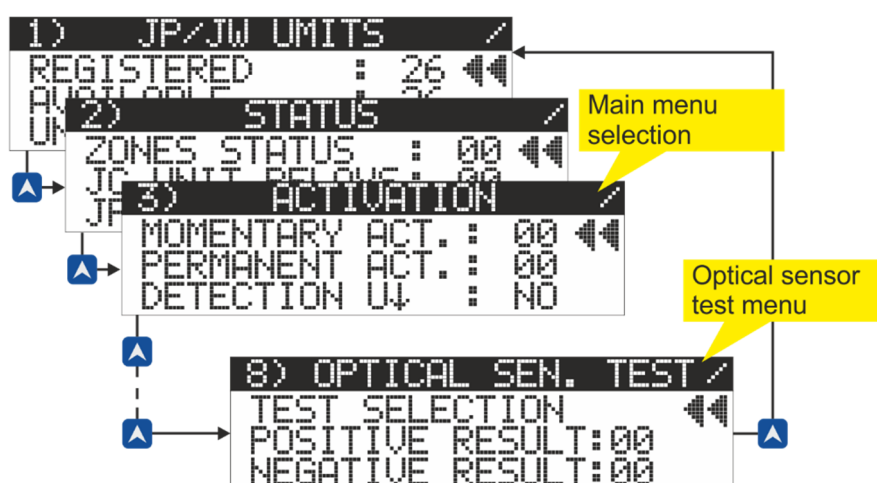


Fig. 47 Selecting the Optical Sensors Test Page.

On the page “OPTICAL SEN. TEST” the user defines which bay units are to be tested by using the submenu “TEST SELECTION”. It is possible to test all the bay units or one can select from the IP addresses list provided in the menu. After running the test the user obtains the number of the bay units with positive test results as well as with the negative test results.

Such data is presented as two submenus: "POSITIVE RESULT:" and "NEGATIVE RESULT:". When picking the IP address of the bay unit from the list "NEGATIVE RESULT:" one can state which of the optical detectors is damaged.

The page offers the following submenus:

Submenu "TEST SELECTION"

TEST ALL – after confirmation by pressing  button the test of all optical detectors is run (see Fig. 48)

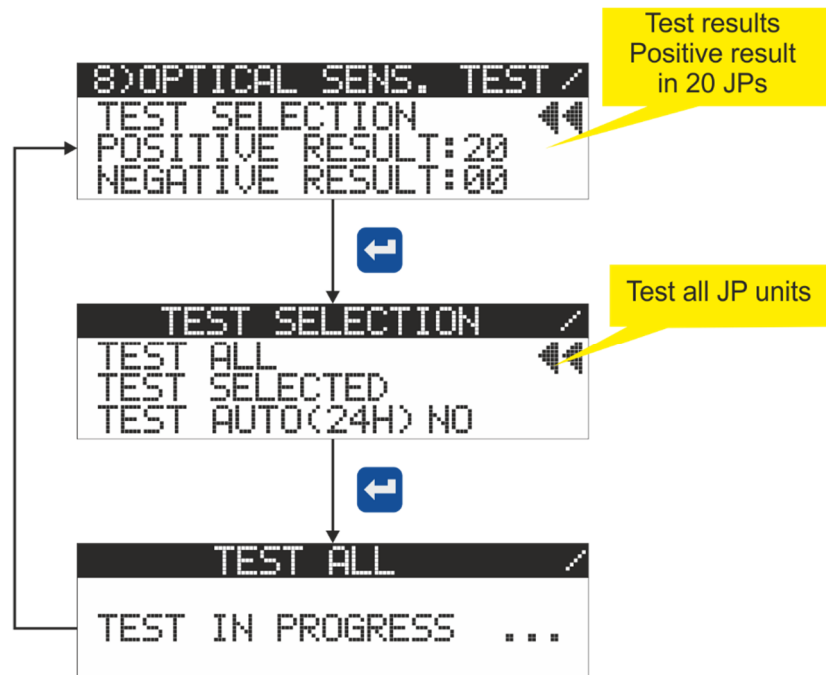


Fig. 48 Test of all optical detectors.

TEST SELECTED – after the user selects this option by  button and confirms by pressing  button the list of available IP addresses of the bay units JPs is displayed.

The choice of a bay unit number is made by pressing  button.

The user confirms the choice of the bay unit number by pressing  button.

It is possible to select several bay units which optical detectors will be tested simultaneously.

Pressing  button runs the test (Fig. 49).

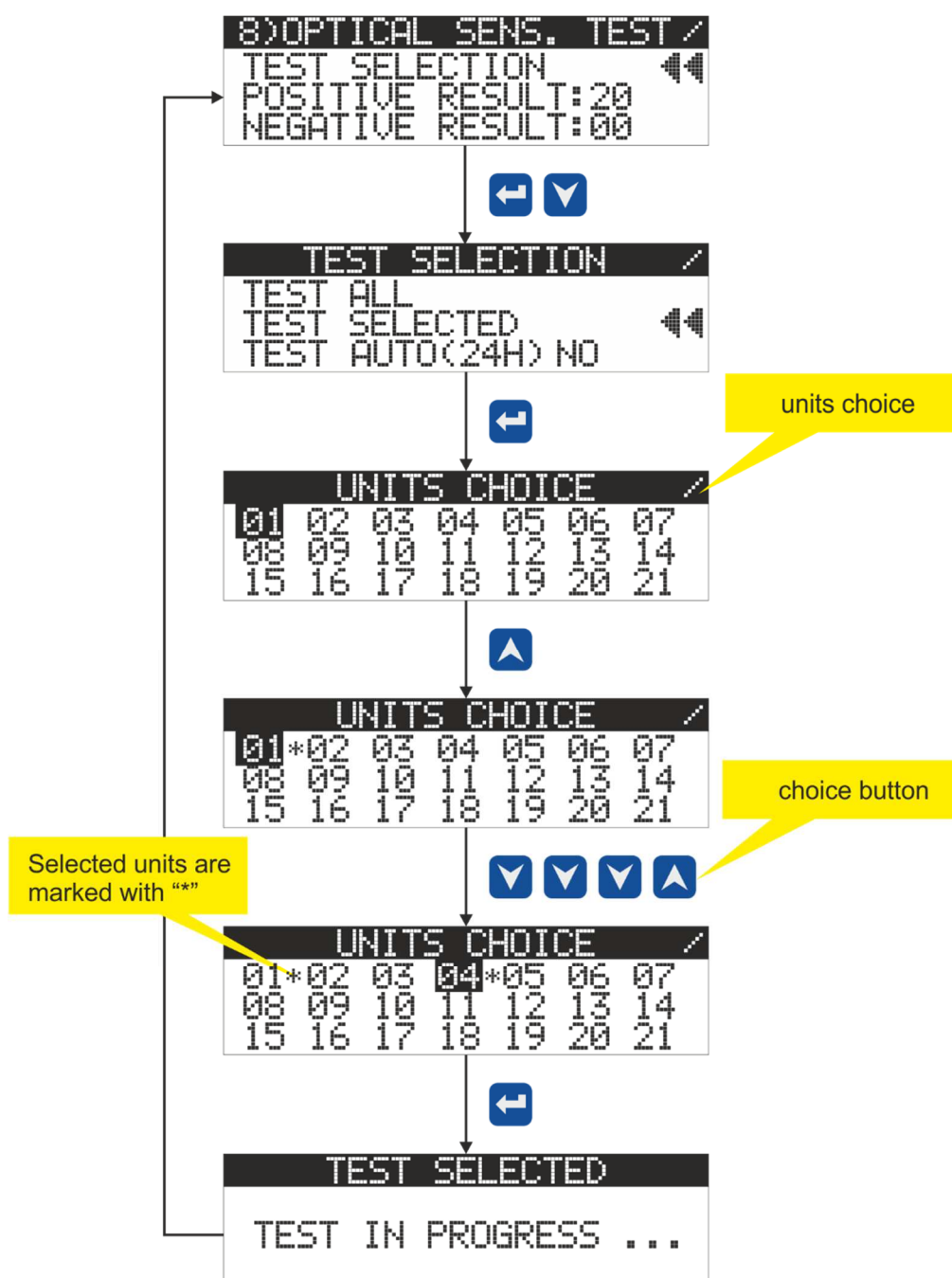


Fig. 49 Test of optical detectors in selected bay units.

TEST AUTO(24 H) – after selecting this option by  button and next by pressing  button the user enables or disables (YES/NO) automatic test of all the optical detectors. Such test is run every 24 hours. Time is measured from the moment of supplying the auxiliary voltage.

Submenu "POSITIVE RESULT: 00"

This submenu returns the number of bay units with positive test result. By selecting this submenu one gains access to the IP list of the bay units which optical detectors have been verified positively.

Submenu "NEGATIVE RESULT: 00"

This submenu returns the number of bay units with negative test result. By selecting this submenu one gains access to the IP list of the bay units which optical detectors have not passed the test.

By selecting  a particular JP address and confirming the choice by pressing  button the user gains access to the detailed information of the selected bay unit. In Fig. 50 the way to localize damaged optical detector is presented. In this figure the detector C1 of the bay unit of the IP address 10 is malfunctioned. Test results are updated during next test run.

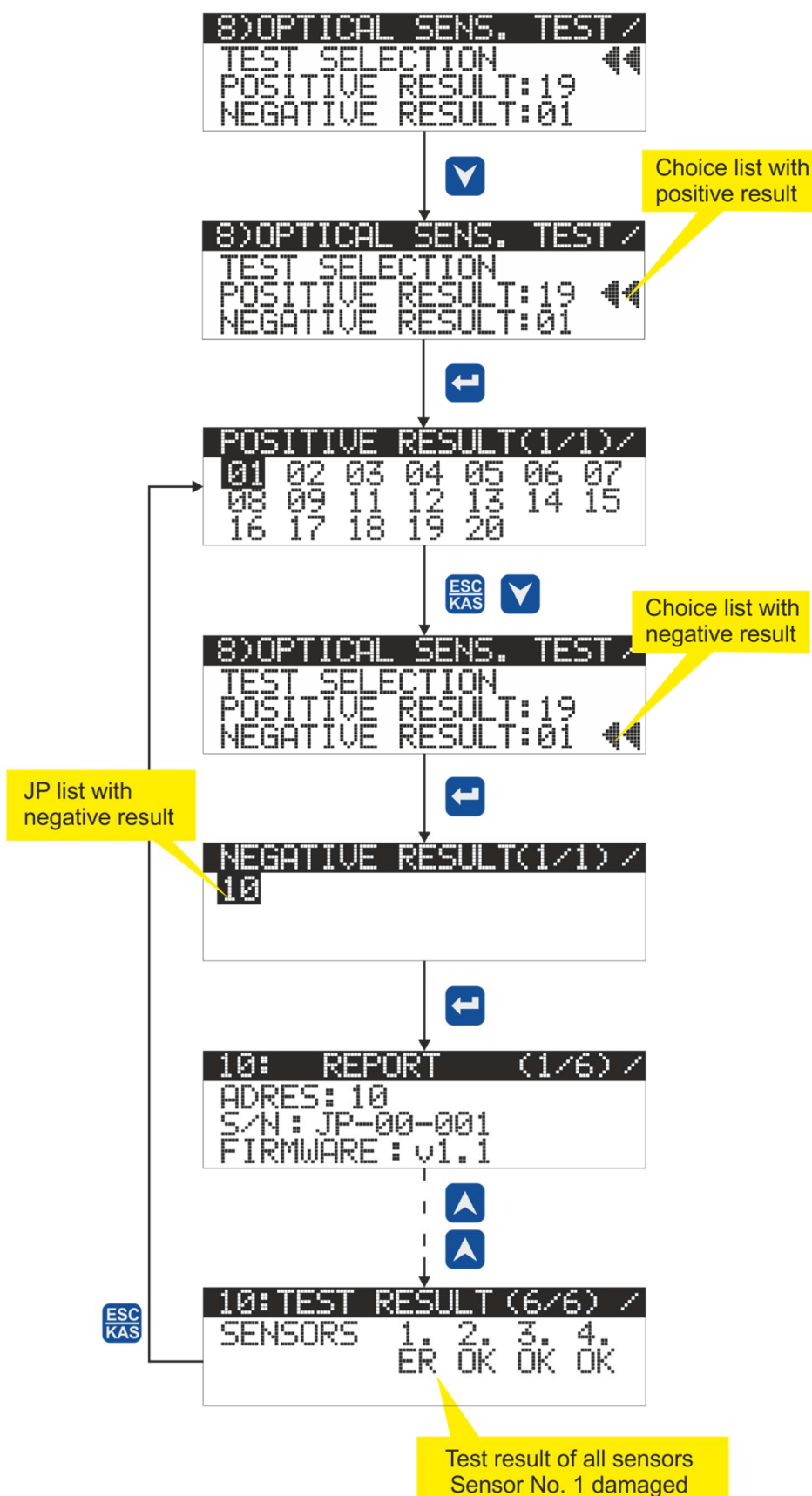


Fig. 50 Damaged optical detector C1 of the bay unit no. 10.

14. Communication ports

Communication among elements of ZŁ-4A system is realized by CAN bus. CAN bus is highly resistant to any disturbances. It possesses low level for EMI emission and also has the high-speed transmission.

Furthermore, the central unit has an isolated galvanic RS485 connection. RS485 connection can service MODBUS RTU protocol, which can be used for communication with a superior system.

14.1. CAN bus

There is a two-wire network with CAN 2.0A (ISO 11898-2: *High Speed CAN Bus*) implemented in ZŁ-4A protection (version 2.0B is not serviced).

Communication protocol has been developed as a company protocol dedicated to ZŁ-4A devices group with the possibility to be expanded in the future for new devices.

The network can be composed of maximum 99 bay units (JP), 5 executive units (JW) and one central unit (JC). Every network element (JP, JW or JC) has two numbers:

- 16-bit, unique serial number set by the producer (*ProductID*); that number is recorded in microprocessor, which controls the device; the serial number is written on the rating plate;
- 8-bit number of the network node, that is the physical address (*NodeID*).

The factory setting of the transmission speed is 250 kbit/s. The maximum length of the CAN bus is 250m.

14.2. RS485 Interface

The central unit is equipped with RS485 communication interface, with the following parameters:

Transmission mode	differential voltage signaling
Type of transmission line	twisted-pair
Transmission Speed	Up to 57 600 bps 19 200 bps (factory settings)
Word length	8
Parity	No
Stop bits	1
Maximum length of the line	1 200 m
Transmitter output	min. $\pm 1,5$ V (for loading 54Ω)
Receiver sensitivity	± 200 mV

The device includes the Modbus RTU Slave protocol. There are the primary inquiries supported, namely #03 – Read Holding Registers, #06 – Preset Single Register, #16 – Preset Multiple Registers. In case of receiving a Modbus frame, which includes some errors, the device displays the error code according to the table below.

Error code	Meaning	Description
1	Illegal Function	Function is not supported
2	Illegal Data Address	Unacceptable register (or registers) address (or addresses)
3	Illegal Data Value	Unacceptable range of information (i.e. the amount of registers)
4	Slave Device Failure	Register record error – the value of register is beyond the acceptable range

Available registers.

M1 Block of registers

There are the following 16-bit registers with the attribute read only [R] (base address: 4000) available:

offset	Register name	Description
0	DeviceSignature	Device identification, the signature has a constant value: 0xaa
1	DeviceCode	Device identification code, constant value: 0x01 (the central unit)
2	DeviceSerialNumber L	Factory device number (the serial number) – lower byte
3	DeviceSerialNumber H	Factory device number (the serial number) – higher byte
4	FirmwareVersion	Firmware Version; 0x12 means v1.2
5	DeviceAlarms	Device Alarms
6	DeviceEvents	Events Register
7	RelayState	Register including the executive relays status
8	RelayMode.RelayP1	Relay P1 working status
9	RelayMode.RelayP2	Relay P2 working status
10	RelayMode.RelayP3	Relay P3 working status
11	RelayMode.RelayP4	Relay P4 working status
12	RelayMode.RelayP5	Relay P5 working status
13	RelayMode.RelayP6	Relay P6 working status
14	RelayMode.DiodeL1	Signal diode L1 working mode
15	UnitsStatus.RegisteredUnits	Register including the total amount of all installed JP/JW units
16	UnitsStatus.PresentUnits	Register including the amount of the installed JP/JW units present in the network
17	UnitsStatus.AbsentUnits	Register including the amount of the installed JP/JW units not present in the network
18	UnitsStatus.AddressCollision	Register including the amount of the installed JP/JW units with wrong network addresses
19	UnitsStatus.SensorFailure	Register including the amount of the installed bay units with damaged optical sensors (permanent damaged)
20	UnitsStatus.SensorSet	Register including the amount of the installed bay units with activated optical sensors
21	UnitsStatus.RelaySetUnits	Register including the amount of the installed bay units with activated relay inputs
22	UnitsStatus.ZoneS1Mode	Register including the amount of the installed bay units with activated “tripping mode in zone S1”

23	UnitsStatus.ZoneS2Mode	Register including the amount of the installed bay units with activated "tripping mode in zone S2"
24	UnitsStatus.ZoneS3Mode	Register including the amount of the installed bay units with activated "tripping mode in zone S3"
25	UnitsStatus.ZoneS1Set	Register including the amount of the bay units that have tripped in zone 1 (event is recorded in the central unit)
26	UnitsStatus.ZoneS2Set	Register including the amount of the bay units that have tripped in zone 2 (event is recorded in the central unit)
27	UnitsStatus.ZoneS3Set	Register including the amount of the bay units that have tripped in zone 3 (event is recorded in the central unit)
28	UnitsStatus.StatusZoneS1Set	Register including the amount of the bay units that have tripped in zone 1 (status is read on the fly)
29	UnitsStatus.StatusZoneS2Set	Register including the amount of the bay units that have tripped in zone 2 (status is read on the fly)
30	UnitsStatus.StatusZoneS3Set	Register including the amount of the bay units that have tripped in zone 3 (status is read on the fly)
31	UnitsStatus.FlashTestOkUnits	Number of bay units which passed the optical sensors test
32	UnitsStatus.FlashTestFailUnits	Number of bay units which have not passed the optical sensors test
33	RemoteRelayMode.RemoteRelayR1	Relay R1 working status
34	RemoteRelayMode.RemoteRelayR2	Relay R2 working status
35	RemoteRelayMode.RemoteRelayR3	Relay R3 working status
36	RemoteRelayMode.RemoteRelayR4	Relay R4 working status
37	RemoteRelayMode.RemoteRelayR5	Relay R5 working status

Register: DeviceAlarms

bit	7	6	5	4	3	2	1	0
	-	-	-	-	-	-	SF	CA

Bit number	Mnemonics	Description
7..2	-	Reserved
1	SF	Permanent activation (damage) of the bay unit optical sensor
0	CA	Lack of communication with bay units, address collision or no bay unit has been registered

Register: DeviceEvents

bit	7	6	5	4	3	2	1	0
	-	-	-	AS3	AS2	AS1	SS	UL

Bit number	Mnemonics	Description
7..5	-	reserved
4	AS3	Tripping in zone S3
3	AS2	Tripping in zone S2
2	AS1	Tripping in zone S1
1	SS	Optical module of the bay unit activation
0	UL	Activation of the voltage module U< of the central unit

Register: RelayState

bit	7	6	5	4	3	2	1	0
	-	R7	R6	R5	R4	R3	R2	R1

Bit number	Mnemonics	Description
7	-	reserved
6..0	R[7..1]	Logical state of the executive relay R[7..1]

Relay R7 performs a signal function. Its value 1 has the meaning of the system efficiency.

Register: RelayMode.ReleayPx

number x denotes the relay output number from 1 to 6.

Register value	meaning	Description
0	RELAY_MODE_OFF	Relay output is inactivated
1	RELAY_MODE_ZONE_S1	Signaling of tripping in zone S1
2	RELAY_MODE_ZONE_S2	Signaling of tripping in zone S2
3	RELAY_MODE_ZONE_S3	Signaling of tripping in zone S3
4	RELAY_MODE_ZONE_S123	Signaling of tripping in zones S1, S2, S3
5	RELAY_MODE_UL	Signaling of the voltage module tripping
6	RELAY_MODE_LOGIC	Signaling of the recorded logical function tripping

Register: RelayMode.DiodeL1

Register value	meaning	Description
0	DIODE_OFF	Signal diode is inactivated
1	DIODE_RELAY_P1	Signaling of relay P1 tripping
2	DIODE_RELAY_P2	Signaling of relay P2 tripping
3	DIODE_RELAY_P3	Signaling of relay P3 tripping
4	DIODE_RELAY_P4	Signaling of relay P4 tripping
5	DIODE_RELAY_P5	Signaling of relay P5 tripping
6	DIODE_RELAY_P6	Signaling of relay P6 tripping
7	DIODE_ALL_RELAY	Signaling of relay P1...P6 tripping

Register: RemoteRelayMode.RemoteRelayRx

number x denotes the relay output number from 1 to 5.

Register value	meaning	Description
0	RELAY_MODE_OFF	Relay output is inactivated
1	RELAY_MODE_ZONE_S1	Signaling of tripping in zone S1
2	RELAY_MODE_ZONE_S2	Signaling of tripping in zone S2
3	RELAY_MODE_ZONE_S3	Signaling of tripping in zone S3
4	RELAY_MODE_ZONE_S123	Signaling of tripping in zones S1, S2, S3
5	-	reserved
6	RELAY_MODE_LOGIC	Signaling of the recorded logical function tripping

M2 Block of registers

There are 16-bit registers with the read-only attribute [R] (base address: 6000) available:

offset	Executive element	zone	Register name
0	P1	S1	P1.S1.REG00
1			P1.S1.REG01
2			P1.S1.REG02
3			P1.S1.REG03
4			P1.S1.REG04
5			P1.S1.REG05
6			P1.S1.REG06
7			P1.S1.REG07
8			P1.S1.REG08
9			P1.S1.REG09
10			P1.S1.REG10
11			P1.S1.REG11
12			P1.S1.REG12
13		S2	P1.S2.REG00
14			P1.S2.REG01
15			P1.S2.REG02
16			P1.S2.REG03
17			P1.S2.REG04
18			P1.S2.REG05
19			P1.S2.REG06
20			P1.S2.REG07
21			P1.S2.REG08
22			P1.S2.REG09
23			P1.S2.REG10
24			P1.S2.REG11
25			P1.S2.REG12
26		S3	P1.S3.REG00
27			P1.S3.REG01
28			P1.S3.REG02
29			P1.S3.REG03
30			P1.S3.REG04
31			P1.S3.REG05
32			P1.S3.REG06
33			P1.S3.REG07
34			P1.S3.REG08
35			P1.S3.REG09
36			P1.S3.REG10
37			P1.S3.REG11
38			P1.S3.REG12

...	P2..P6	...	...
234	L1	S1	L1.S1.REG00
235			L1.S1.REG01
236			L1.S1.REG02
237			L1.S1.REG03
238			L1.S1.REG04
239			L1.S1.REG05
240			L1.S1.REG06
241			L1.S1.REG07
242			L1.S1.REG08
243			L1.S1.REG09
244			L1.S1.REG10
245			L1.S1.REG11
246			L1.S1.REG12
247		S2	L1.S2.REG00
248			L1.S2.REG01
249			L1.S2.REG02
250			L1.S2.REG03
251			L1.S2.REG04
252			L1.S2.REG05
253			L1.S2.REG06
254			L1.S2.REG07
255			L1.S2.REG08
256			L1.S2.REG09
257			L1.S2.REG10
258			L1.S2.REG11
259			L1.S2.REG12
260		S3	L1.S3.REG00
261			L1.S3.REG01
262			L1.S3.REG02
263			L1.S3.REG03
264			L1.S3.REG04
265			L1.S3.REG05
266			L1.S3.REG06
267			L1.S3.REG07
268			L1.S3.REG08
269			L1.S3.REG09
270			L1.S3.REG10
271			L1.S3.REG11
272			L1.S3.REG12

PX – relay output P1...P6,

L1 – signal diode “RELAY EXE”.

Register: REG00

bit	7	6	5	4	3	2	1	0
	JP_08	JP_07	JP_06	JP_05	JP_04	JP_03	JP_02	JP_01

Register: REG01

bit	7	6	5	4	3	2	1	0
	JP_16	JP_15	JP_14	JP_13	JP_12	JP_11	JP_10	JP_09

Register: REG02

bit	7	6	5	4	3	2	1	0
	JP_24	JP_23	JP_22	JP_21	JP_20	JP_19	JP_18	JP_17

Register: REG03

bit	7	6	5	4	3	2	1	0
	JP_32	JP_31	JP_30	JP_29	JP_28	JP_27	JP_26	JP_25

Register: REG04

bit	7	6	5	4	3	2	1	0
	JP_40	JP_39	JP_38	JP_37	JP_36	JP_35	JP_34	JP_33

Register: REG05

bit	7	6	5	4	3	2	1	0
	JP_48	JP_47	JP_46	JP_45	JP_44	JP_43	JP_42	JP_41

Register: REG06

bit	7	6	5	4	3	2	1	0
	JP_56	JP_55	JP_54	JP_53	JP_52	JP_51	JP_50	JP_49

Register: REG07

bit	7	6	5	4	3	2	1	0
	JP_64	JP_63	JP_62	JP_61	JP_60	JP_59	JP_58	JP_57

Register: REG08

bit	7	6	5	4	3	2	1	0
	JP_72	JP_71	JP_70	JP_69	JP_68	JP_67	JP_66	JP_65

Register: REG09

bit	7	6	5	4	3	2	1	0
	JP_80	JP_79	JP_78	JP_77	JP_76	JP_75	JP_74	JP_73

Register: REG10

bit	7	6	5	4	3	2	1	0
	JP_88	JP_87	JP_86	JP_85	JP_84	JP_83	JP_82	JP_81

Register: REG11

bit	7	6	5	4	3	2	1	0
	JP_96	JP_95	JP_94	JP_93	JP_92	JP_91	JP_90	JP_89

Register: REG12

bit	7	6	5	4	3	2	1	0
	-	-	-	-	-	JP_99	JP_98	JP_97

Bit JP_xx signals the bay unit of the address xx (xx in range 01..99) assignment to the logical function of the specified zone Sx (x: zone from 1 to 3) and an executive element P1...P6, L1.

M3 Block of registers

There are 16-bit registers with the read-only attribute [R] (base address: 6000) available:

offset	Executive element	zone	Register name
0	R1	S1	R1.S1.REG00
1			R1.S1.REG01
2			R1.S1.REG02
3			R1.S1.REG03
4			R1.S1.REG04
5			R1.S1.REG05
6			R1.S1.REG06
7			R1.S1.REG07
8			R1.S1.REG08
9			R1.S1.REG09
10			R1.S1.REG10
11			R1.S1.REG11
12			R1.S1.REG12
13		S2	R1.S2.REG00
14			R1.S2.REG01
15			R1.S2.REG02
16			R1.S2.REG03
17			R1.S2.REG04
18			R1.S2.REG05
19			R1.S2.REG06
20			R1.S2.REG07
21			R1.S2.REG08
22			R1.S2.REG09
23			R1.S2.REG10
24			R1.S2.REG11
25			R1.S2.REG12
26		S3	R1.S3.REG00
27			R1.S3.REG01
28			R1.S3.REG02
29			R1.S3.REG03
30			R1.S3.REG04
31			R1.S3.REG05
32			R1.S3.REG06
33			R1.S3.REG07
34			R1.S3.REG08
35			R1.S3.REG09
36			R1.S3.REG10
37			R1.S3.REG11
38			R1.S3.REG12
...	R2..R5	...	...

RX – relay output R1...R5,

Rejestr: REG00

bit	7	6	5	4	3	2	1	0
	JP_08	JP_07	JP_06	JP_05	JP_04	JP_03	JP_02	JP_01

Rejestr: REG01

bit	7	6	5	4	3	2	1	0
	JP_16	JP_15	JP_14	JP_13	JP_12	JP_11	JP_10	JP_09

Rejestr: REG02

bit	7	6	5	4	3	2	1	0
	JP_24	JP_23	JP_22	JP_21	JP_20	JP_19	JP_18	JP_17

Rejestr: REG03

bit	7	6	5	4	3	2	1	0
	JP_32	JP_31	JP_30	JP_29	JP_28	JP_27	JP_26	JP_25

Rejestr: REG04

bit	7	6	5	4	3	2	1	0
	JP_40	JP_39	JP_38	JP_37	JP_36	JP_35	JP_34	JP_33

Rejestr: REG05

bit	7	6	5	4	3	2	1	0
	JP_48	JP_47	JP_46	JP_45	JP_44	JP_43	JP_42	JP_41

Rejestr: REG06

bit	7	6	5	4	3	2	1	0
	JP_56	JP_55	JP_54	JP_53	JP_52	JP_51	JP_50	JP_49

Rejestr: REG07

bit	7	6	5	4	3	2	1	0
	JP_64	JP_63	JP_62	JP_61	JP_60	JP_59	JP_58	JP_57

Rejestr: REG08

bit	7	6	5	4	3	2	1	0
	JP_72	JP_71	JP_70	JP_69	JP_68	JP_67	JP_66	JP_65

Rejestr: REG09

bit	7	6	5	4	3	2	1	0
	JP_80	JP_79	JP_78	JP_77	JP_76	JP_75	JP_74	JP_73

Rejestr: REG10

bit	7	6	5	4	3	2	1	0
	JP_88	JP_87	JP_86	JP_85	JP_84	JP_83	JP_82	JP_81

Rejestr: REG11

bit	7	6	5	4	3	2	1	0
	JP_96	JP_95	JP_94	JP_93	JP_92	JP_91	JP_90	JP_89

Rejestr: REG12

bit	7	6	5	4	3	2	1	0
	-	-	-	-	-	JP_99	JP_98	JP_97

Bit JP_xx signalizes the bay unit of the address xx (xx in range 01..99) assignment to the logical function of the specified zone Sx (x: zone from 1 to 3) and an executive element R1...R5.

M4 Block of registers

There are 16-bit registers with the read-only attribute [R] (base address: 8000) available.

The bay units JP:

offset	bay unit network address	Register name	Description
0	0	UnitsConfig.Serial L	Factory bay unit number (the serial number) – lower byte
1		UnitsConfig.Serial H	Factory bay unit number (the serial number) – higher byte
2		UnitsConfig.Control	Bay unit network status
3		UnitsConfig.Status	Bay unit working status
4		UnitsConfig.SensorState	Bay unit optical sensors status
5		UnitsConfig.SensorSet	Bay unit optical sensors activation status
6		UnitsConfig.SensorFailure	Bay unit optical sensors permanent activation (damage) status
7		UnitsConfig.SensorMode[C1]	Bay unit optical sensor C1 status
8		UnitsConfig.SensorMode[C2]	Bay unit optical sensor C2 status
9		UnitsConfig.SensorMode[C3]	Bay unit optical sensor C3 status
10		UnitsConfig.SensorMode[C4]	Bay unit optical sensor C4 status
11		UnitsConfig.FlashTestStatus	Status of bay unit optical sensors test
...	1..98	...	...
1188	99	UnitsConfig.Serial L	Factory bay unit number (the serial number) – lower byte
1189		UnitsConfig.Serial H	Factory bay unit number (the serial number) – higher byte
1190		UnitsConfig.Control	Bay unit network status
1191		UnitsConfig.Status	Bay unit working status
1192		UnitsConfig.SensorState	Bay unit optical sensors status
1193		UnitsConfig.SensorSet	Bay unit optical sensors activation status
1194		UnitsConfig.SensorFailure	Bay unit optical sensors permanent activation (damage) status
1195		UnitsConfig.SensorMode[C1]	Bay unit optical sensor C1 status
1196		UnitsConfig.SensorMode[C2]	Bay unit optical sensor C2 status
1197		UnitsConfig.SensorMode[C3]	Bay unit optical sensor C3 status
1198		UnitsConfig.SensorMode[C4]	Bay unit optical sensor C4 status
1199		UnitsConfig.FlashTestStatus	Status of bay unit optical sensors test

UnitsConfig.Serial: register values from 0 or 65535 (0xffff) should be interpreted in the following way: there is no registered bay unit with this particular number (other registers values assigned to this particular network address are unimportant – they should not be decoded). Other values of the register mean that this network address is occupied by another bay unit in the system.

Register: UnitsConfig.Control

bit	7	6	5	4	3	2	1	0
	-	-	AS3	AS2	AS1	AC	UP	UR

Bit number	Mnemonics	Description
7..6	-	Reserved
5	AS3	Registered bay unit tripping in zone S3
4	AS2	Registered bay unit tripping in zone S2
3	AS1	Registered bay unit tripping in zone S1
2	AC	Wrong bay unit network address
1	UP	Bay unit is available in the network
0	UR	Bay unit is registered in the system

Register: UnitsConfig.Status

bit	7	6	5	4	3	2	1	0
	-	RL	SF	SS	RAS1	AS3	AS2	AS1

Bit number	Mnemonics	Description
7	-	Reserved
6	RL	Bay unit executive relay status
5	SF	Damaged optical sensors signaling
4	SS	Activated optical sensors signaling
3	RAS1	Signaling of remote tripping in zone S1
2	AS3	Signaling of tripping in zone S3
1	AS2	Signaling of tripping in zone S2
0	AS1	Signaling of tripping in zone S1

Register: UnitsConfig.SensorState

bit	7	6	5	4	3	2	1	0
	-	-	-	-	P4	P3	P2	P1

Bit number	Mnemonics	Description
7..4	-	Reserved
3..0	P[4..1]	Logical state of optical sensor C[4..1]

Register: UnitsConfig.SensorSet

bit	7	6	5	4	3	2	1	0
	-	-	-	-	P4	P3	P2	P1

Bit number	Mnemonics	Description
7..4	-	Reserved
3..0	P[4..1]	Optical sensor C[4..1] activation

Register: UnitsConfig.SensorFailure

bit	7	6	5	4	3	2	1	0
	-	-	-	-	P4	P3	P2	P1

Bit number	Mnemonics	Description
7..4	-	Reserved
3..0	P[4..1]	Optical sensor C[4..1] damage

Register: UnitsConfig.SensorMode[Cx]

where x – optical sensor number 1..4

bit	7	6	5	4	3	2	1	0
	-	-	-	-	-	-	MxA	MxB

Bit number	Mnemonics	Description
7..2	-	Reserved
1..0	M[4..1]A, B	Optical sensor working mode C[4..1]

MxA, MxB	Cx optical sensor working mode
0 0	Inactivated
0 1	Optical sensor Cx tripping in zone Z1
1 0	Optical sensor Cx tripping in zone Z2
1 1	Optical sensor Cx tripping in zone Z3

Register: UnitsConfig.FlashTestStatus

bit	7	6	5	4	3	2	1	0
	C4A	C4B	C3A	C3B	C2A	C2B	C1A	C1B
MxA, MxB	Optical sensors test status							
0 0	test has not been performed							
0 1	test performed but the sensor not checked (off in the bay unit)							
1 0	test performed but the sensor damaged							
1 1	test performed and the sensor operational							

The executive units JW:

offset	Executive unit network address	Register name	Description
1200	100	UnitsConfig.Serial L	Factory executive unit number (the serial number) – lower byte
1201		UnitsConfig.Serial H	Factory executive unit number (the serial number) – higher byte
1202		UnitsConfig.Control	Executive unit network status
1203		UnitsConfig.Status	Executive unit working status
1204		--	Reserved
1205		--	Reserved
1206		--	Reserved
1207		--	Reserved
1208		--	Reserved
1209		--	Reserved
1210		--	Reserved
1211		--	Reserved
...	101..103	...	...
1248	104	UnitsConfig.Serial L	Factory executive unit number (the serial number) – lower byte
1249		UnitsConfig.Serial H	Factory executive unit number (the serial number) – higher byte
1250		UnitsConfig.Control	Executive unit network status
1251		UnitsConfig.Status	Executive unit working status
1252		--	Reserved
1253		--	Reserved
1254		--	Reserved
1255		--	Reserved
1256		--	Reserved
1257		--	Reserved
1258		--	Reserved
1259		--	Reserved

Rejestr: UnitsConfig.Control

bit	7	6	5	4	3	2	1	0
	-	-	-	-	-	AC	UP	UR

Bit number	Mnemonics	Description
3..6	-	Reserved
2	AC	Wrong executive unit network address
1	UP	Executive unit is available in the network
0	UR	Executive unit is registered in the system

Rejestr: UnitsConfig.Status

bit	7	6	5	4	3	2	1	0
	-	RL	-	-	-	-	-	-

Bit number	Mnemonics	Description
7	-	Reserved
6	RL	Executive unit executive relay status
0..5	-	Reserved

M5 Block of registers

There are 16-bit registers with the write-only attribute [W] (base address: 10000) available.

offset	Register name	Description
0	TaskRegister	Launching an optical detector test

Rejestr: TaskRegister

bit	7	6	5	4	3	2	1	0
	-	-	-	-	-	-	-	OT

Bit number	Mnemonics	Description
1..7	-	Reserved
0	OT	Optical detector test (setting „1” – test start of all detectors)

15. Operating

15.1. Periodic check of the protection operation

During a properly managed operation of the arc fault protection systems the check-up of the operation of the protection should be carried out during the periodic inspections of the switchgears or during their out-of-service time. The check-up should cover the control of:

- activation of optic detectors,
- activation of voltage elements,
- external and internal signaling circuits,
- activation of all tripping circuits by simulating an arc fault.

At least once a year, apart from the functional check, the operate time of the protection should be checked.

The producer provides services, repairs and periodic tests of the arc fault protection systems.

15.2. Exchange of optic elements after an arc fault appearance

After an arc fault appearance the optical detectors of the arc fault protection are usually not to be used anymore, even if they do not appear damaged. As a result of the arc acting the sensitivity of the optical detectors may be changed (due to smoke or temperature influence) and simultaneously the sensitivity of the whole protection is modified. Exchange of the optical detectors should be managed according to the manuals of the optical detectors.

15.3. Detection and elimination of the damage

The device possesses the self-diagnostics system that provides instantaneous signaling of most of inner failures. After detecting a failure by the self-diagnostics system or by the personnel it is necessary to describe symptoms of the failure and to consult them with the representative of the producer service in order to obtain instructions for further procedure. It is not recommended to make any repairs by the user without previous arrangement with the producer of the device.

16. Storing

Transport packaging should have the same vibrations and strokes endurance as it is specified in standards PN-EN 60255-21-1:1999 and PN-EN 60255-21-2:2000 for the sharpness of the class 1.

The device delivered by the producer should be unpacked carefully not with use of too much strength and not adequate tools. After unpacking it should be visually checked if the device has no external damage.

The device should be stored in a dry and clean place. The temperature of the storage is in the range from -25°C up to $+70^{\circ}\text{C}$.

Relative humidity should be in such a range that condensation and hoarfrost would not occur.

The devices should be installed at their workplaces about 2 hours before supplying. It is necessary to equalize temperature and to avoid humidity and condensation.

17. Utilization

If it is necessary to disassemble the device (and eventually remove it) as the result of a damage or the end of its operation life time, all the supplying and measurement units and other connections should be switched off before.

The disassembled device should be treated as electronic scrap which undergoes appropriate regulations concerning waste management.

18. Warranty and service

For the delivered device SPIE Energotest Ltd. provides a 12-month warranty from the date of purchasing (unless the contract states otherwise), based on the rules specified in the guarantee certificate.

The producer ensures technical assistance during the start-up of the device and provides warranty service under the commonly accepted conditions and after warranty service under the conditions mutually agreed on.

Not obeying the rules specified above causes the loss of warranty.

19. Ordering

The order should include:

- the amount of the central units ZŁ-4A JC,
- the amount of the bay units ZŁ-4A JP,
- the amount of the bay units ZŁ-4A JW,
- the amount of the power supplies,
- the amount of the optical detectors with specified length, the maximum length of the fiber reserve is 1 meter,
- the type of the switchgear where the protection will be installed,
- name and contact details of the person who can provide additional information on the order, installation and configuration of the protection.

The orders should be sent to the producer to the following address:

SPIE Energotest sp. z o.o.

ul. Chorzowska 44B; 44-100 Gliwice

phone: +48-32-270 45 18

e-mail: energotest@spie.com

<https://www.spie-energotest.pl>

----- End of operating manual -----