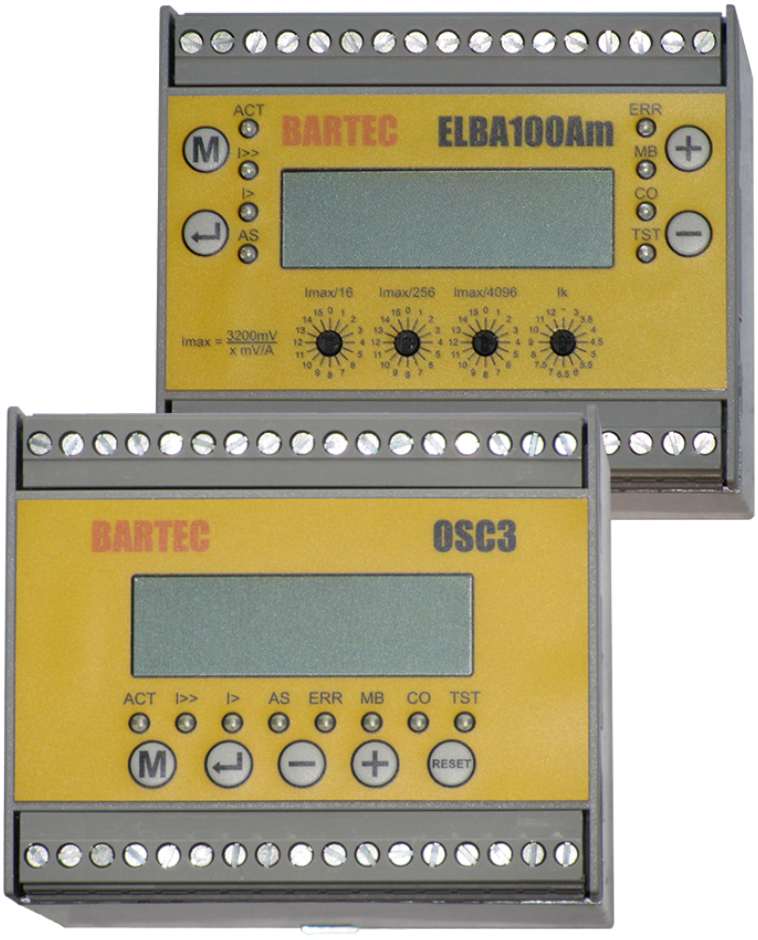
Overload and Short-Circuit protections for 3-phase outlets OSC3 i ELBA100Am type

Operation Manual no. BP/IO/04/09

EXPROTEC



EXPROTEC Sp. z o.o.
43-100 Tychy
ul. Graniczna 26A
tel: +48 32 326 44 00
email: biuro@exprotec.pl

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1 Introduction

The Operation and Safety Manual, no. BP/IO/04/09 is intended to provide the users of the OSC3 i ELBA100Am relay (also referred to as „the product") with the product design, operating principle and procedures of safe and correct operation.

1.1 Copyright

1.2 Warranty terms and conditions

The warranty terms and conditions are specified in BARTEC's „General Terms and Conditions of Sale and Delivery".

All warranty claims and/or claims for material or personal damage will be rejected whenever caused by:

- non-intended use of the product,
- improper transport, handling, storage, installation, wiring, commissioning, servicing, maintenance, repairs, removal and/or recycling,
- non-compliance with this Manual,
- unauthorized modifications in the connection layout of the product,
- improper inspection of wearing parts of the product,
- emergency caused by contact with foreign bodies or other causes.

2 Safety of operation

The product shall only be installed by qualified personnel trained in operation of Ex-rated electrical equipment.

During operation, observe the requirements for maintaining the efficiency of the device, in accordance with the documentation.

The protection features shall be calibrated according to their operating manuals approved for use by the mine operations manager or another competent authority.

All repairs and maintenance of the OSC3 i ELBA100Am shall be attempted with the live supply voltage isolated and locked out from the equipment unit it is integrated with.

3 Identification of hazards

3.1 Hazards

The Operation Manual specifies sufficiently the correct maintenance of the product. However, the personnel attempting maintenance shall hold valid electrical licenses.

WARNING: Read this Operation Manual prior repairing or maintaining this product.

WARNING: Do not attempt to repair the product if you do not have the required qualifications. Only BARTEC is authorized for the repairs. Improper or careless repair can lead to serious accidents or death.

WARNING: Modification of the product or use of any spare part which does not comply with BARTEC's engineering conditions may result in severe injury and/or death hazards and will result in loss of warranty rights and product approval.

3.2 Application restrictions

The field installation of the product shall follow the Operation Manual.

RESTRICTION: Do not attempt any makeshift installation of the product.

RESTRICTION: The ambient temperature limits are: $-20°C \leq Ta \leq +70°C$.

3.3 Directions for safe use

1. Prior to operating the product, read and understand this Operation and Safety Manual. Refer also to the documentation of the system in which the product is operated.
2. Compliance with the Operation Manual and the guidelines and parameters listed in the system documentation will guarantee reliable operation of the product. The user shall strictly comply with the rules of operation. Non-compliance may result in loss of warranty right, damage of the product or create operating hazards.
3. The management in the product user's organisation is required to provide adequate training for prospective operators of the product.
4. The only operators authorized to work with the product shall be properly qualified.
5. Follow all applicable health and safety regulations and this Manual.
6. Do not modify the product or use it with any spare parts which do not meet BARTEC's specifications for genuine spare parts. Unauthorized attempts at repairs of the product may result in severe hazards to the operators and other personnel, and void the warranty, certification and/or approvals.
7. All test instrument used for servicing of electrical equipment components shall comply with applicable regulations.
8. Troubleshoot and maintain the product in witness of a trained assistant capable of isolating the main power supply and providing first aid as necessary.
9. Any attempt at starting failed electrical equipment may result in hazards to operator's health or life and failure to other equipment.

4 Intended use

The OSC3 i ELBA100Am relay type is designed for protection and control functions of one three-phase outlet / load.

Product functions:

- current protection (overload, shorting, current asymmetry),
- warning alarm for load making,
- power load operation control,
- operation of actuators,
- contactors control,
- display of operating status and messages,
- data output to other control and monitoring system.

The OSC3 i ELBA100Am relay can be applied in the following equipment types:

- contactor switches,
- compact stations,
- transformer units,
- transformer and power distribution substations,
- frequency converters,
- other switchgear types of 3-phase AC power systems installed in underground mine workings or other industrial facilities.

The product is also intended as a protection of power loads and motors operated in explosion hazard zones.

5 Operating conditions

For explosion hazard zones, the product is intended for operation if confined to an external flameproof enclosure marked with the Ex d making or in non-hazardous areas if confined to an enclosure with a minimum ingress protection rating IP54 (IP65).

Table 1: Enclosure technical specifications

Enclosure technical specifications		
Oveall dimensions (width x height x depth)	90 × 65 × 110	mm
Weight	0,5	kg

Table 2: Operating conditions

Operating conditions		
Maximum installation elevation	≤1000	m
Ambient temperature	−20…+70	°C
Relative humidity (non-condensing) at 40°C	≤95	%
Transport temperature	−20…+60	°C
Transport relative humidity	≤95	%
Mechanical exposure – frequency	10…55	Hz
Mechanical exposure – amplitude	0,35	mm
Vibration resistance (10…55Hz)	0,5	g
Impact strength	7	Nm
Operating orientation	any	—
Duty	continuous	—

6 Technical parameters

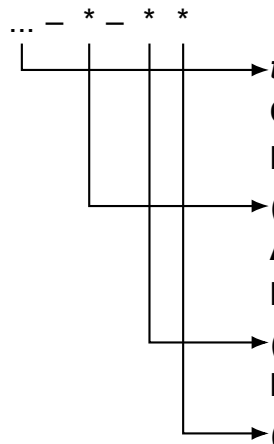
Table 3: Technical parameters

Technical parameters		
Power input AC/DC	3	W/VA 50Hz
Rated supply voltage DC/DC	24/42	V
Range of allowed AC supply voltage	17…53	V
Range of allowed DC supply voltage	19…75	V
Relay mechanical strength	$3 \cdot 10_7$	
Rated load	250VAC 4A 120VAC 3A 240VAC 1,5A 30VDC 4A 120VDC 0,22A 250VDC 0,1A	AC1 AC15 AC15 DC1 DC13 DC13
Short-circuit stage triggering time	>30	ms
Overload stage triggering time	>40	ms
Asymmetry stage triggering time	>40	ms
Insulation strength between coil and contacts	5	kV
Strength of open contacts insulation	1000	V AC/DC
IP rating	IP20	
Maximal diameter of cord connected to terminal	2.5	mm
Maximal diameter of wire connected to terminal	4	mm
Short-circuit stage adjustment range[1]	2,0…12	I_r/I_n
Asymmetry stage adjustment range	10…60	% I_n
Rated current I_n adjustment range for 25mV/A transducer[2]	0,1…128	A
Rated current I_n adjustment range for 10mV/A transducer[2]	0,25…320	A
Rated current I_n adjustment range for 5mV/A transducer[2]	0,5…640	A
Rated current I_n adjustment range for 3mV/A transducer[2]	1,0…1066	A
Rated current I_n adjustment range for 1mV/A transducer[2]	2,5…2500	A
Relative error of indication (dla I > $0.1I_n$) [50Hz]	5	% I_n
Resistance of measuring circuit input	32	kΩ
Capacitance of measuring circuit input	100	nF
Maximal instantaneous peak voltage at the measuring inputs (L poles in relation to N)	53.5	$V_{max\ peak}$
Maximal voltage at the digital inputs (L poles in relation to N)	*(ref. supply voltage)*	
Digital input resistance	20	kΩ
Galvanic insulation of digital inputs[3]	500	V_{RMS}
Test time of digital inputs galvanic insulation	60	s
Galvanic insulation of communication lines and 0…10V output	500	V_{RMS}
Test time of communication lines galvanic insulation and 0…10V output	60	s

[1] full range of settings see chapter 18
[2] When the multiplication factor of short-circuit stage is set to 12.
[3] No insulation between individual inputs.

7 Identification

7.1 Type



typ:

OSC3 – standard version

ELBA100AM – version with knobs for current adjustment

(manufacturing version):

A – basic version [4]

P – version for PMB-1 relay [5]

(communication options):

M – version supporting the ModBus protocol

(additional inputs):

0÷7 – number of additional inputs [4] [5]

Example of designation: **OSC3-A-M0**. The OSC3 overload and short-circuit protection supporting the ModBus protocol, without additional inputs and control of relay operation.

Another example of designation: **OSC3-P-M**. The OSC3 overload and short-circuit protection sup-porting the Modbus protocol dedicated for multifunctional relay PMB-1.

Other example of designation: **ELBA100Am-P-M**. The ELBA100Am overload and short-circuit protection supporting the Modbus protocol dedicated for multifunctional relay PMB-1 equipped with knobs for volt-free current adjustment.

8 Construction

8.1 Mechanical part

The overload and short-circuit protection is installed in a housing (EG-90 or EH 90 type) which is intended for mounting on TS35 bus.

The front part (fig. 1) of the protection includes two connectors: X1 (pos. 1) and X2 (pos. 2), LCD display (pos. 3), buttons (pos. 4), diodes informing on the device state (pos. 5) and knobs for volt-free current adjustment (pos. 6).

The signalling diodes have the following meanings:

ACT – Pulsating with the frequency of 1Hz, signalling the device operation.
I>> – Short-circuit stage signalling.
I> – Overload stage signalling.
AS – Asymmetry stage signalling.
ERR – Data error signalling.
MB – Signalling of communication.
CO – Reserved.
TST – Signalling of incorrect settings (more detailed description can be found in the part regarding the device configuration).

[4] discontinued
[5] for version „P" number of additional inputs is not given (blank)

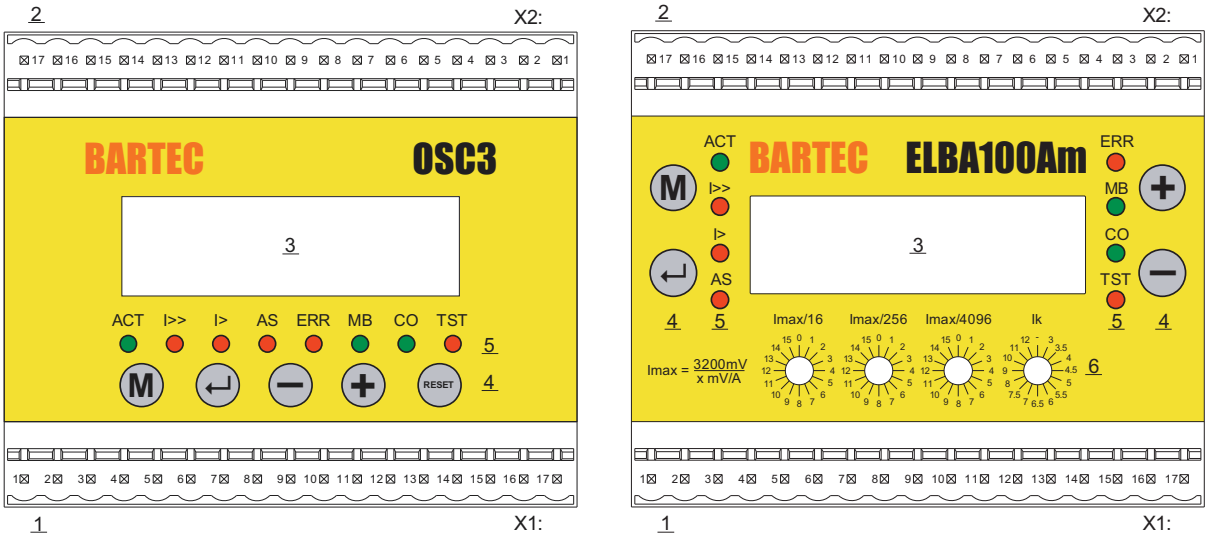


Figure 1: General view

The device is fitted with 5 buttons in the OSC3 or 4 buttons in ELBA100Am version[6]:

- M – „MENU”
- ↵ – „ENTER”
- – – „Minus”
- + – „Plus”
- RESET – „Reset”

The following signals are assigned to the device terminals:

X1:1 – Measuring input **IL1** of L1 phase transducer (pole **„I”**).
X1:2 – Measuring input **IL2** of L2 phase transducer (pole **„I”**).
X1:3 – Measuring input **IL3** of L3 phase transducer (pole **„I”**).
X1:4 – Common input **IKN** – transducers earthing (poles **„k”**).
X1:5 – Reserved **NC**.
X1:6 – Digital input **I0**.
X1:7 – Digital input **I1**.
X1:8 – Digital input **I2**.
X1:9 – Digital input **I3**.
X1:10 – Digital input **I4**.
X1:11 – Digital input **I5**.
X1:12 – Digital input **I6**.
X1:13 – Digital input **I7**.
X1:14 – Common terminal (neutral) **IN** for all digital inputs.
X1:15 – Reserved **NC**.
X1:16 – Supply **A1**.
X1:17 – Supply **A2**.
X2:1 – Contact of **K11** relay.
X2:2 – Contact of **K12** relay.
X2:3 – Contact of **K13** relay.
X2:4 – Contact of **K14** relay.
X2:5 – Contact of **K15** relay.

[6]No RESET button.

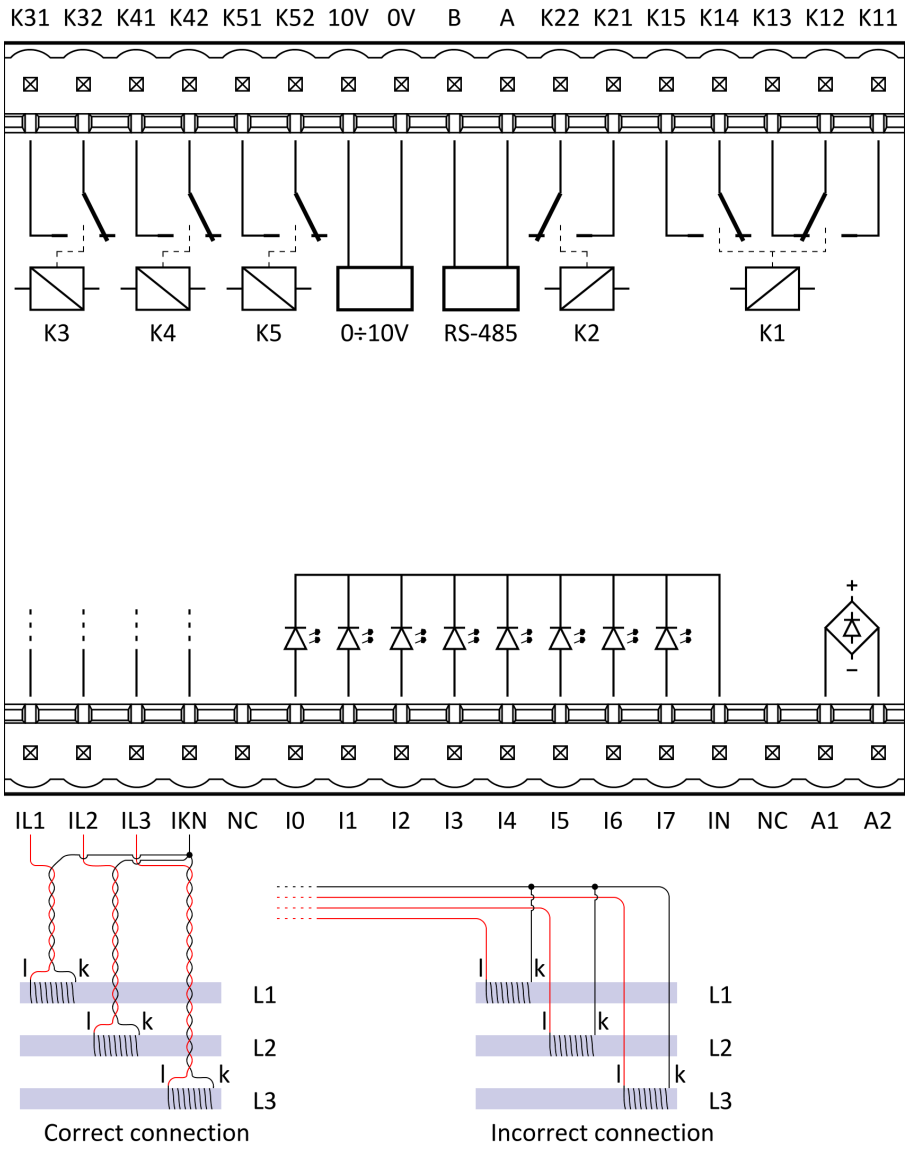


Figure 2: Block diagram and transducers connection
(information on relays configuration can be found on page 23)

X2:6 – Contact of **K21** relay.
X2:7 – Contact of **K22** relay.
X2:8 – Wire **A** of RS−485 interface.
X2:9 – Wire **B** of RS−485 interface.
X2:10 – Negative terminal of **0V** ÷ 10V output.
X2:11 – Positive terminal of 0V ÷ **10V** output.
X2:12 – Contact of **K52** relay.
X2:13 – Contact of **K51** relay.
X2:14 – Contact of **K42** relay.
X2:15 – Contact of **K41** relay.
X2:16 – Contact of **K32** relay.
X2:17 – Contact of **K31** relay.

8.2 Electric equipment

Presented overload and short-circuit protection is designed to protect the 3-phase outlet against the effects of short-circuit, overloading or phase currents asymmetry. If the asymmetry stage is switched off it is possible to use the protection for single-phase circuits. In such a case, it is recommended to connect the unused measuring inputs to X1:4 terminal.

The protection operates with external current-voltage transducers connected to X1:1 ÷ X1:4 terminals. It has a broad range of settings, depending on applied transducers. It is also possible to apply the current transformers, because after their shorting with a small resistance a signal can be expressed in [mV/A]. The transducers should be connected with a twisted pair cable (in case of difficulties in measurements, especially for small currents, it is recommended to use a shielded twisted pair cable with a shield connected to PE, connection to PE in one point exclusively), and the connection of transducers' "**k**" poles should be made as close to X1:4 terminal as possible.

The communication with the device is realized through text messages shown on the display. The device menu is operated with buttons. The fifth button – "RESET" (if provided) allows the protection resetting after its triggering. The protection is fitted with diodes signalling its operational state. In basic version the protection is fitted with 2 relays or 5 relays in version for PMB. The device can be accessed remotely through the RS−485 interface, with using of Modbus RTU protocol.

In the standard version the device is fitted with one digital input (**I0**), which serves as the external input for resetting the messages appearing on the display (equivalent of "RESET" button). Optionally the device can be equipped with more inputs, marked as additional inputs **I1** ÷ **I7**. They are a general-purpose inputs and their logic status is signalled on the display and can be read remotely. The relay also is fitted with analog output 0V ÷ 10V which is scaled with respect to the specified nominal current.

9 Preparation for work

9.1 Installation

The overload and short-circuit protection of OSC3 i ELBA100Am type can be installed in areas not endangered by explosion, in the housings with minimal rating of IP54 or in areas endangered by explosion, in the flame-proof housings. The protection cannot be installed in separated flame-proof connecting chambers of devices.

9.2 Electric shock protection

Due to the fact that dangerous voltages may occur on the protection's terminals the safety regula-tions and general rules of proceeding in such conditions should be observed.

10 Storage and transport conditions

The protection should be kept in closed storage rooms, at the temperature from −20 to +50°C and relative humidity up to 75%, free from harmful vapours and gases.

11 Inspections and maintenance principles

It is recommended to conduct the periodic controls of relay functionality and electric connections correctness. The protection settings should be checked after each change of the overload and/or short-circuit stage settings, and not less than:

1. before putting the unit into service,
2. in forehead installations – once a year,
3. in non-forehead installations:
   (a) with a voltage up to 1kV – once every 3 years,
   (b) with a voltage above 1kV – once a year.

12 Disposal

After passing of the operational period the device must be disposed in accordance with applicable regulations regarding the environment protection.

In case when user does not have an appropriate knowledge in this scope he should obtain information from a proper office of local authorities.

13 Differences between OSC3 i ELBA100Am relays

The main difference between the two types of devices lies in the way of setting the rated current and short circuit stage. The ELBA100Am type relay is equipped with knobs (fig. 1) for volt free adjustment of these two parameters. The first three knobs allow dividing a maximum current, which is equivalent of setting the value of the rated current. The maximum current is dependent on the ratio of the current transducers and is expressed as 3200[mV]/(x [mV/A]), where x is the ratio of the current transducers multiplied by number of turns of wires going through the current transducer. For example ratio 5 mV/A and 2 wire turns in transducers is same as ratio 10 mV/A. The first knob allows you to split the maximum current value by 16 (x/16). The second divides the smallest unit of the first knob by 16 (y/16), which results in division of the maximum current by 256. Consequently, the third knob divides the smallest unit of the second knob by 16 (z/16), so the maximum current is divided by 4096. The fourth knob is used for setting short circuit stage. Menu options for these settings are read only.

Example: You need to set the rated current of 91 A and on the outlet are installed transducers 5 mV/A. The maximum current in this case is 3200[mV]/5[mV/A] = 640A. At first you should set all knobs to zero. Then start adjustment of the first knob (640/16 = 40). For x = 2 rated current is 80 A, for x = 3 it is 120 A so leave knob in position which results in less than the desired value, i.e. x = 2. Next, start adjustment of the second knob (640/256 = 2,5) where for y = 4 rated current is 90A (4 • 2,5A = 10A; 80A + 10A = 90A) and for y = 5 it is 92,5A, so the second knob should be left in the position y = 4. Then follows adjustment of the third knob (640/4096 = 0,156), where for z = 7 is obtained rated current 91A (7 • 0,156A = 1,09A; 90A + 1,09A ≈ 91A). The whole can be written as follows:

$$I_n = I_{\max} \bullet \left(\frac{x + \frac{y + \frac{z}{16}}{16}}{16} \right) = 640\text{A} \bullet \left(\frac{2 + \frac{4 + \frac{7}{16}}{16}}{16} \right) \approx 91\text{A}$$

Or otherwise:

$$I_n = I_{max} \bullet \left(\frac{x}{16} + \frac{y}{256} + \frac{z}{4096} \right) = 640A \bullet \left(\frac{2}{16} + \frac{4}{256} + \frac{7}{4096} \right) \approx 91A$$

Whilst performing these adjustments there should be no current flow to outlet. The device after powering up shows the set value of the rated current, which frees the user from carrying out calculations described above. In case of setting parameters out of range of allowed settings, the device will immediately disconnect all relays and the **TST** diode will light up signalling incorrect settings.

14 0V ÷ 10V output

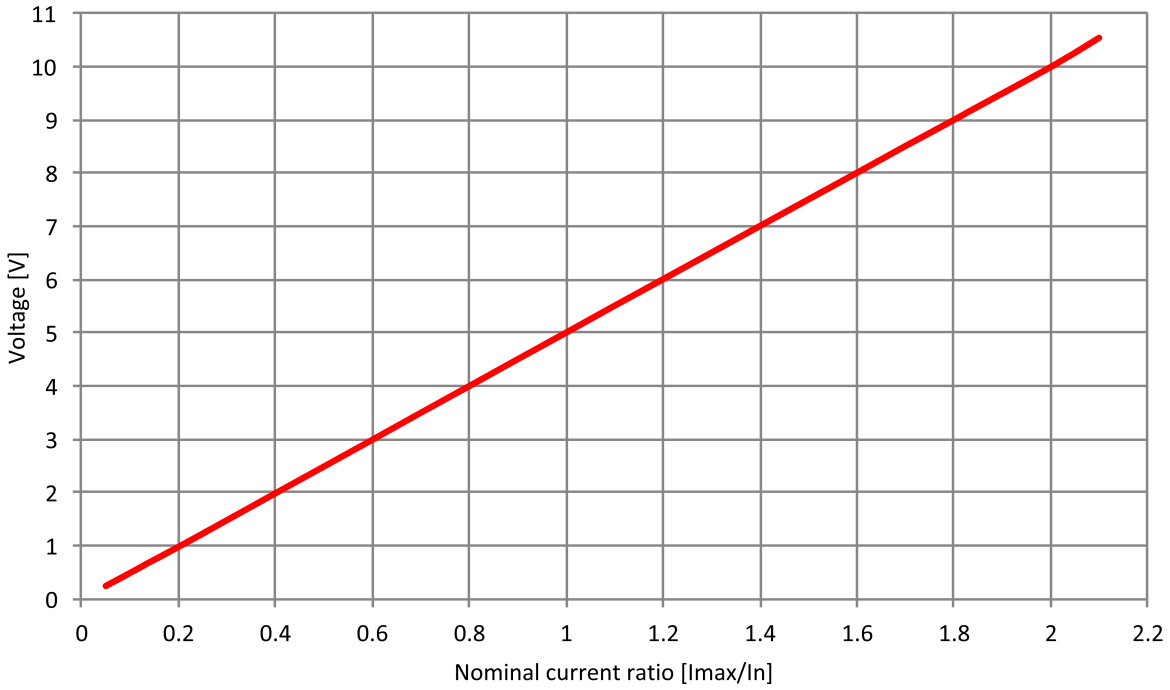


Figure 3: Analog output voltage in relation to current ratio

Device is equipped with insulated 0V ÷ 10Vanalog output. The output voltage is proportional to the maximum instantaneous phase current with respect to specified nominal current. When the ratio is equal to one the output voltage is equal to 5V. Typical voltage waveform depending on the current ratio values is shown in figure 3.

15 Version for PMB-1 relay

Device in version for **PMB-1** multifunctional safety relay acts as a control device. In this version has ad-ditional relays **K3** ÷ **K5**, in NO configuration. In total there are 4 relays in NO configuration and one relay in NO+N C configuration.

Each relay can be assigned to respond to short-circuit (**I>>**), overload (**>I**), asymmetry (**AS**), lack of continuity of the protective conductor (**PE**), locking earthing (⏚**B**) and central

(⏚**C**), over-temperature (**T>**), the control advance signal (**CA** – Control Advance), the control signal (**C** – Control), the signal activity from the safety switch (**NA** – Not-Aus), the start signal (**R** – Run), the stop signal (**H** – Halt)), activation of 2_{nd} gear (**2**), error (**Err**) and control confirmation signal (**A**).

To inputs **I0** ÷ **I7** can be assigned: external reset signal (**Rst**), the signal of module controlling the continuity of the protective conductor (**PE**), the over-temperature (**T>**), the control module earthing (⏚**CB**), signal of switching the Not-Aus safety switch (**NA**), the start signal (**R**), the stop signal (**H**), external control of activation of 2_{nd} gear (**2**) and control confirmation signal (**A**).

The device in version for **PMB-1** uses the last 4 input signals to the implementation of the boot sequence. The implementation requires two timing parameters and the choice of pulse or continuous control. In the first case it is sufficient to drive the signal pulse of **R** signal and in the second it is required to maintain continuous control signal.

The first inflicted parameter is the duration of the control advance signal (**CA**), which can be in set in range 1 ÷ 240s and the second parameter is the time of waiting for confirmation switching control signal (**A**), which can be chosen in range 0.1 ÷ 2.5s. If duration of advance signal is set then the pulse of the start signal (**R**) causes activation of the control advance signal (**CA**) for the set time after its expiration control signal (**C**/**C1**) is activated. Control remains active for the time of waiting for the confirmation. If within this time no control confirmation signal (**A**) is obtained, control signal is deactivated.

In each case the activity of the stop signal **H** (break-off circuit) or inactive start signal **R** in continuous control mode immediately disables control signal and control sequence needs to be started from the beginning.

If control of 2_{nd} gear will be activated then further parameters are available. Delay time for triggering of the 2_{nd} gear is counted from the moment of triggering of 1_{st} gear of obtaining acknowledgement if it participates in the control. In case of external control of the 2_{nd} gear, triggering before elapsing of this time is causes an error. Another parameter is a pause time between switching off 1_{st} gear (if this option is active) and triggering of the 2_{nd} gear. Acknowledgement signal of triggering of both gears is read by one input and thus the logic generating correct acknowledgement signal should be implemented outside the device. Waiting time for acknowledgement of the triggering in case of inactive switching off option of the 1_{st} gear before triggering of the 2_{nd} gear. This pause should end before elapsing time for requiring acknowledgement of triggering for 2_{nd} gear. Control of 1_{st} gear is signalled with symbol (**C1**) and for the second gear by (**C2**). Triggering of contacts of both gears is signalled with symbol (**C12**).

Activity of any stage of the overload and short-circuit protection is indicated by standard error messages and have higher priority. Signals: **PE**, **T>**, ⏚**C**, ⏚**B**, **CA**, **C**, **C1**, **C2**, **C12**, **A**, **NA**, **R**, **H**, **2**, **Err**, in the event of their activity and in the right side of display during normal operation of OSC3 and have lower priority. In addition, the menus are expanded configuration options for inputs, relays and the parameters of the boot sequence.

16 Menu and configuration

16.1 Menu structure

A general diagram of protection's menu is shown on the figure 4. Arrows drawn with dashed line represent the moves, which are performed by the device. In case of other moves, there are symbols of buttons responsible for performing of a given move.

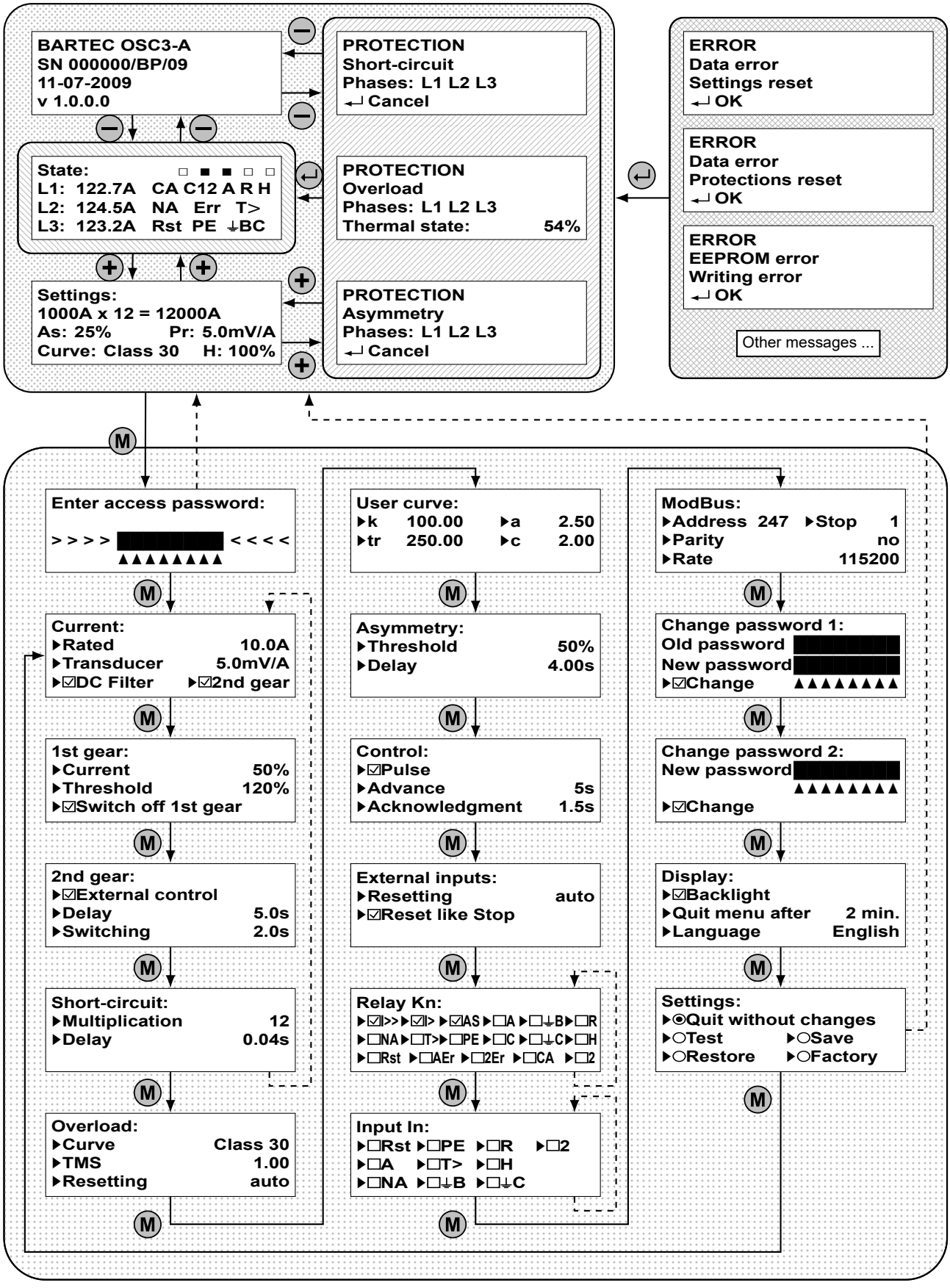


Figure 4: Menu of device

The darkened areas have the following meanings:

– measuring data,
– messages on protection stages triggering,
– device state,
– error messages,
– configuration menu area.

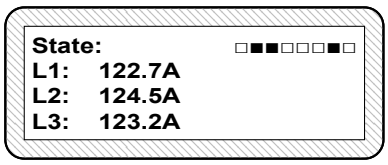
16.2 Rules of menu using

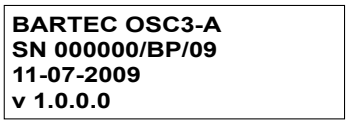
The general rules of device menu operation are described below. Moving between individual screens is realized with using of the „MENU” (M). button. The user can switch between individual positions on a given menu screen by pressing the „ENTER” (↵) button. Values can be changed with using of „PLUS” (+) and „MINUS” (–) buttons, which increase and decrease a given value respectively. The „►” symbol located next to a given position or the „▲” symbol located below it means that this position is a currently changed value. In case of on/off positions their states are signalled by „☑” and „◉” or „☐” and „○” symbols respectively. In addition to that it is possible to quit menu immediately by holding the „MENU” (M) button and simultaneous pressing of the „ENTER” (↵) button once. Messages can be cancelled by pressing the „ENTER” (↵) or „RESET” (RESET) buttons.

16.3 Current values

16.3.1 Basic version

The first screen shows the effective values of the phase currents. Small squares located in the right upper corner indicate read out logic statuses of digital inputs. The square located at the very left corresponds to the **I0** input. The squares are displayed only for physically existing inputs. The second screen includes information on the device:



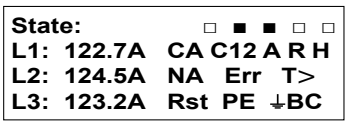


Line 1: Symbol of device version,
Line 2: Serial number,
Line 3: Date of indications correctness control by manufacturer,
Line 4: Software version.

User can switch between described screens pressing the „MINUS” (–) button.

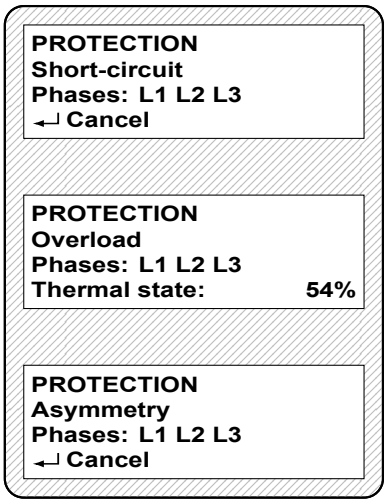
16.3.2 Version for PMB-1

In version for multifunctional relay PMB-1 status screen is different. Its appearance is presented next. The upper square symbols indicate in this case status of relays driving. Underneath are shown the symbols indicating the status of the input signal and the developed output signals. The symbols appear when the signal is active. In the event of external manual reset signal mode errors in their activity is stored until manually reset. The meaning of symbols is explained in the section 15.



16.4 Signalling of protection triggering

The screens informing on the protection triggering include the following elements:



Line 1: Title consisting the word PROTECTION.

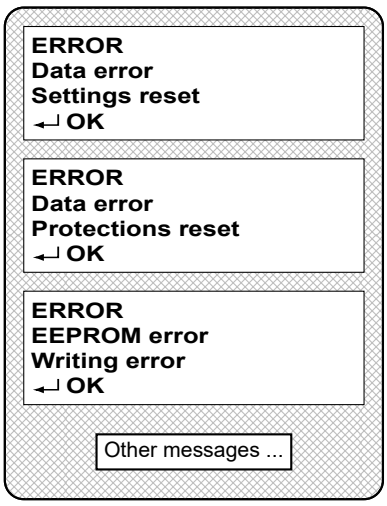
Line 2: Includes information, which protection stage was triggered. The signalling of the short-circuit stage has the highest priority, then the signalling of the overload stage and asymmetry stage (the lowest priority).

Line 3: Includes information, which phases caused the triggering of a given protection.

Line 4: Includes the prompt to reset a triggered stage by pressing the „ENTER" button. In case of the overload stage the thermal condition which left to be reset is signalled, and when it decreases to the threshold value the message can be reset manually or automatically. All the protection stages, which can be reset at a given moment are reset.

16.5 Error messages

The screen informing on error occurrence in the device consists of the following elements:



Line 1: Title consisting the word „BŁĄD".

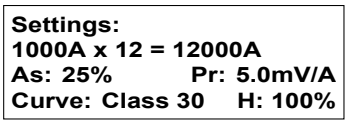
Line 2: Consists information on error type. It can be a „Data error" of data saved in EEPROM or an „EEPROM error" signalling a physical problem with writing, i.e. a problem with EEPROM itself.

Line 3: Includes information what action will be undertaken by the device in order to resolve an existing situation. If the configuration data are damaged then the default settings will be restored, and if the information of protection stages activity is damaged, then the state of these stages will be reset.

Line 4: Includes the prompt to reset a triggered stage by pressing the „ENTER" button.

In case when EEPROM memory is damaged, then the device should be returned to the manufacturer in order to replace a defective element. If the message informing on EEPROM error appears first time, then it is possible that the device will work after reset, but the user takes all responsibility for the abnormalities in further operation of the device, in spite that the manufacturer made any efforts to ensure that the device is completely safe even in such situation. Appearing of any error message means that all relays go into inactive state.

16.6 View of settings



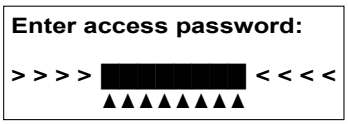
If the present data on currents in individual phases or a screen signalling that the protection was triggered are displayed, then it is possible to go to the screen titled „Settings" (which is shown beside) by pressing the „PLUS" ⊕ button. It allows to view the most important settings without the necessity to have an access to the protection's configuration menu. The values presented in the second line include the preset rated current, the multiplication of rated current corresponding to the short-circuit current and the product of these two values, i.e. the preset short-circuit current (they are displayed in the same order as they are listed). Hyphens in this place mean that the short-circuit protection is switched off. Data presented in third and fourth lines regard (in such order as they are listed) the maximal allowed **As**ymmetry (hyphens indicate that the asymmetry stage is switched off), **Curve** of the overload protection characteristics and the ratio of the **Tr**ansducers itself. The position marked as **H** means themal state (maximum of 3 phases).

NOTE: *In order to return to the previous screen press the „PLUS" ⊕ button again.*

It is also possible to display this screen by entering an active state on the **Rst** input of the device. The screen will appear after 5 seconds. After releasing the signal device will return to the previous screen.

16.7 Configuration

16.7.1 Password screen



Press the „MENU" Ⓜ button in order to enter the protection's configuration menu. If the device does not signal an error, then it will go to the screen in which the access password is to be entered. If all the password digits are not entered or the entered password is incorrect, then the previous screen will be displayed automatically when the „MENU" Ⓜ button is pressed. If the entered password is correct then the next screen will be displayed.

NOTE: *The user has no possibility to recover a lost access password. In case when the user forgot the access password it can be changed only by the manufacturer, after delivering the device to manufacturer's premises.*

16.7.2 Screen of current settings

It allows to set up the rated current of the receiver and/or receiver. The „Rated" position allows to set up the rated current. In two-gear control this is a current of the 2_{nd} gear. Selection of „DC Filter" option allows filtering out of the constant component from the measured signal. Option „2nd gear" activates control of the 2_{nd} gear of the motor. The „Transducer" indicates the preset value of the current transducer ratio. If the settings exceed the allowed range of the input voltage, then the **TST** diode will light up, signalling incorrect states, and the possibility to move to the next configuration screen will be blocked. In such a case the preset settings should be changed, until the **TST** diode lights off. The best solution is to use a transducer with a lower ratio. Similarly the **TST** diode can light up in case when very small currents are measured. In such a case increase the number of coils and/or the ratio, until the diode lights off.

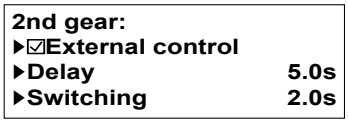
The current settings screen is connected strictly with the successive screens until the short-circuit stage settings screen, because the possible settings of current depend also on the preset multiplication of short-circuit and rated current of the 1_{st} gear. If the preset settings are infeasible then the **TST** diode is on and the user can only switch between these screens until presetting of set points that are possible for implementation.

In case when current transformers are applied it is suggested to short the transducers with secondary current of 5A with 0.1Ω 5W resistor, and to short the transducers with secondary current of 1A with 0.5Ω 2W resistor. The resistors with tolerance worse than 1% should not be applied in order to avoid an excessive measurement errors resulting from limited accuracy of the transducers. Generally the maximal voltage level resulting from a transducer and resistance, the tolerance and power dispersed on resistors and transformers should be taken into consideration when selecting the resistor.

The user must be aware that if the settings are close to the minimal settings, i.e. I_N = 0.5A and short-circuit multiplication of 10 for 25mV/A transducer, then the signal corresponding to the rates current of 0.5A is 2.5mV, for the short-circuits 5A and 25mV/A respectively. The device can work with such signals, but the interference with amplitudes on the level of measured signals and even many times higher may occur in given conditions. The user must be aware of such phenomena because they can make the measurement completely impossible. In such cases at least one of the following methods of this problem resolving should be applied: use a transducer with a higher ratio and/or pull the wire with measured current many times through the transducer window. If the currents are small then the wires with small sections are sufficient, as they cause no problem to pull them many times through the transducer. Another method is to apply a shielded twisted pair cable between the transducer and the device, shielding the transducers from the environment or even between each other. The shield should be connected to PE, the only correct way of shield connection is to connect it in one point only. It is not recommended to run the wires parallel with power cables or other cables, in which the current or voltage signals with high amplitudes occur. Using of too long wires transmitting the signal from transducers can also be troublesome. Then they should be shortened. Also the use of air-core transducers is a high risk of susceptibility to interference. It is then necessary to use transducers with magnetic circuit. This is especially important in systems with inverters and taking measurements of currents of several amperes and smaller. Due to the fact that it is impossible to predict the configurations in which the protection will work the decision on necessary measures is left to the end user's assessment and responsibility.

16.7.3 Screens with control settings in two-gear mode

These screens are displayed after activation of control of 2_{nd} gear. First contains options connected with 1_{st} gear. „Current" parameters specifies rated current of 1_{st} gear as percent of current of gear 2. „Threshold" parameters specifies maximum current of 1_{st} gear at which it is possible to trigger 2_{nd} gear. This option can be switched off. Marking of option „Switch off 1st gear" causes switching off the control of 1_{st} gear before triggering of 2_{nd} gear.

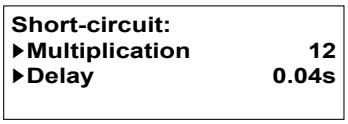


Another screen sets the parameters connected with 2_{nd} gear. Option „external control" allows manual triggering of 2_{nd} gear. Then user should control delay time after triggering or acknowledgement of triggering of 1_{st} gear and maximum current for triggering of 2_{nd} gear. Not meeting rigours saved in the device will result in error. „Delay" parameters specifies time

for delay of triggering of 2_{nd} gear after triggering or obtaining acknowledgement of triggering of 1_{st} gear. Parameter „Switching" specifies pause time between switching off 1_{st} gear and triggering 2_{nd} gear.

16.7.4 Short-circuit stage settings screen

This screen allows to configure the short-circuit stage settings. The option: „Multiplication" means the multiplication of the rated current at which the phase current will be considered as short-circuit. Switching of the element is signalled by the „off" text. The „Delay" position indicates the detection time. The stage will be triggered if the exceeding of the current threshold value is detected in each 5 ms period. Stage triggering is signalled by lighting of **I>>** diode. If any of the relays is configured to react to the short-circuit stage triggering then an appropriate message will be displayed. Otherwise the **I>>** diode lights off automatically after short-circuit disappearing. This screen is strictly connected with the current settings screen and two-gear control screens. A more detailed description can be found in the description of above-mentioned screens.

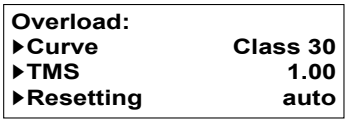


NOTE: *The message on short-circuit stage triggering is always cancelled manually.*

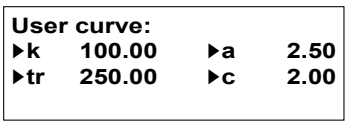
NOTE: *The triggering time is the sum of the delay time and the own time of stage triggering.*

16.7.5 Overload stage settings screen

The „Curve" position allows to select the characteristics of the overload stage. TMS coefficient applies to time constant of characteristics defined in the EN 60255-151. The „Reset" position allows to select if the state of the overload triggering will be reset automatically when the thermal condition of motor drops to the threshold value, enabling the motor restart.



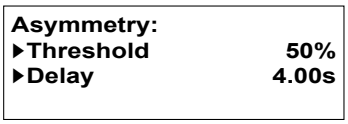
Screen „User curve" allows defining own parameters of the overload characteristics acc. to the standard EN 60255-151. This screen is displayed only after selection of the user curve.



NOTE: *It is not possible to switch the overload stage off.*

16.7.6 Asymmetry stage settings screen

The „Threshold" option allows to select the threshold of asymmetry stage triggering. The hyphens on this position mean that the asymmetry stage is switched off. The „Delay" position indicates the detection time. The stage will be activated if the asymmetry is detected in each 10 ms period. The stage triggering is signalled by lighting of **AS** diode. If any of relays is configured to react to the asymmetry stage triggering, then an appropriate message will be displayed. Otherwise the **AS** diode lights off automatically after asymmetry disappearing.



NOTE: *The message on asymmetry stage triggering is always cancelled manually.*

NOTE: *The triggering time is the sum of the delay time and the own time of stage triggering.*

16.7.7 Control stage settings screen

Control stage settings screen is available only in version for multifunctional relay PMB-1. The „Pulse" option allows to choose between the pulse control algorithm and continuous control algorithm. This option influences also input controlling the 2_{nd} gear. The „Advance" option specifies the duration of the control advance signal timing, and the „Acknowledgment" specifies the waiting time for acknowledgment of switching on. Switching off both options is signalled by the text „off". For information see section 15.

```
Control:
▸☑Pulse
▸Advance              5s
▸Acknowledgment     1.5s
```

16.7.8 External input signals settings screen

This screen is available only in version for multifunctional safety relay PMB. The first option allows you to determine whether information about the external errors, such as ground fault and over-temperature will be reset automatically after the resignation, or whether their occurrence is to be stored on or reset is done manually. The second option allows you to choose if external reset input breaks control sequence like stop signal.

```
External inputs:
▸Resetting            auto
▸☑Reset like Stop
```

NOTE: *The reset of the acknowledgment error and safety switch is always manual.*

16.7.9 Relays configuration screens

These screens allow to assign the protection stages to the relays. If a position is selected that it means that a given relay will go to inactive state when the stage assigned to it is triggered. If more than one stage is assigned to a given relay then its final state will be the logic sum of activity signals from individual protection stages. It is necessary to assign the overload stage at least to one relay. Otherwise the **TST** diode signalling the incorrect configuration will light up and the „MENU" (M) button will allow only to move between the relay configuration screens. The **I>>** symbol means the short-circuit stage, the **I>** symbol means the overload stage and the **AS** symbol means the asymmetry stage.

```
Relays 1:
K1   ▸☑I>>  ▸☑I>   ▸☑AS
K2   ▸☐I>>  ▸☐I>   ▸☐AS
K3   ▸☐I>>  ▸☐I>   ▸☐AS
```

```
Relays 2:
K4   ▸☐I>>  ▸☐I>   ▸☐AS
K5   ▸☐I>>  ▸☐I>   ▸☐AS
K6   ▸☐I>>  ▸☐I>   ▸☐AS
```

NOTE: *In this case the „MINUS" (−) button serves exceptionally to move between the options of protection stages of a given relay (moving horizontally) and the assignment is selected only by pressing the „PLUS" (+) button.*

NOTE: *There are two screens allowing the configuration of relays in the example above, in order to understand well the principles of operation. The number of these screens and their contents can vary, depending on device version and the number of relays installed in a given version.*

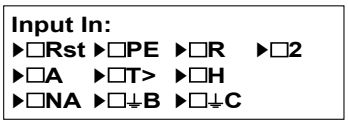
NOTE: *A relay without assigned protection stages remains inactive.*

16.7.10 Configuration screens of relays and inputs in version for PMB-1

Version designed for multifunctional relay PMB-1 has a modified configuration screens of relays and additional screens for inputs. The buttons „PLUS” ⊕ and „MINUS” ⊖ are intended to switch between different positions on the screen, and the „ENTER” ↵ button is used to select items.

First presented next screen shows the configuration of the relay and the second configuration of the inputs. The meaning of symbols is explained in the chapter 15. In case of control in two-gear mode the **C** option is replaced by option **1**, which activates control of the 1_{st} gear.

For practical reasons there are not possible any assignments. For relays, the overload stage is always assigned to the K1 relay. Signals that cannot be combined with others are: **A**, **R**, **C**, **1**, **2** and **CA**. Signals **A** and **R** have inverted polarity of driving relays. For inputs, it is necessary to assign the external reset to at last one input. The following signals cannot be combined: **Rst**, **R**, **1**, **2** and **A**. If control acknowledgment is necessary both the start signal and the acknowledgment signal must be assigned. Signals that can be combined are **H** with **NA**, as well as **PE**, **T>** and ⏚. The signals **H**, **NA**, **PE**, **T>** and ⏚ are active low state (no voltage) and the other are active high state (by giving the voltage).



16.7.11 ModBus settings screen

This screen allows to configure the parameters of communication with using of Modbus protocol. The „Address” position allows to select an address at which the protection is available in the network. The „Stop” position allows to select the number of stop bits. The „Parity” position allows to select the parity control of sent data or to disable it. The „Rate” position allows to set the rate of data exchange in bits per second.

16.7.12 Access passwords change screens

These screens allows to change the access password to the protection configuration menu. The password consists of eight digits. There are two passwords.

The first password gives full access to configuration of device. In order to change this password enter all the digits of the current password and all the digits of a new password. In addition to that the user should confirm that he wants to change the password by checking the „Change” option. If this option is checked and there is any error or omission in the old or new password, then the **TST** diode will light up and it will be impossible to quit the menu until the data are corrected.

The second password allows to change only the rated current, and settings of short circuit and asymmetry stages (without delay times). Other options are read only. This password is changed in similar way as it has been previously described and is possible only after entering the first password. If the passwords are identical, the first password has priority.

16.7.13 Menu settings screen

The „Backlight” position on this screen allows to select if the display backlight is switched on. The option „Quit menu after” allows to set up the idle time with active menu, after which the menu will be quitted automatically. The option „Language” allows to select in which language the protection communicates with user.

```
Display:
▸☑Backlight
▸Quit menu after      2 min.
▸Language             English
```

NOTE: *The language in which the messages are displayed will be changed at the moment when the „MENU”* (M) *button is pressed. The settings should be saved in order to remember the changes.*

16.7.14 Executive screen

This screen allows to decide what to do with changes introduced during configuration. The „Quit without changes” option causes that the introduced changes will be forgotten. The „Test” option will cause that the changes will be applied without their saving (e.g. after restart the previous settings will be read in). The „Save” option will cause saving and applying of new settings. The „Restore” option will cause that the stored settings will be read in and applied. The last option „Factory” will cause that the factory settings will be read in and applied (except passwords and menu language).

```
Settings:
▸⦿Quit without changes
▸○Test          ▸○Save
▸○Restore       ▸○Factory
```

NOTE: *It is not possible to select more than one option. Selecting of any option will cause that an appropriate action will be performed and the menu will be quitted. If no option is selected then the display will return to the current settings screen. These actions will be performed when the „MENU”* (M) *button is pressed.*

17 Overload characteristics

17.1 Standards EN 60255-149 and EN 60947-4-1

The class of characteristics, meeting the conditions specified in the table 4 are implemented in the overload stage of the protection. Response time curves for cold and hot states are presented in figures 5 and 6. In the case of testing response times from cold state, the initial thermal state should not exceed 1%. Then, its effect on time measurement can be considered negligible. When testing response times from hot state, the initial thermal state shall be equal to 70.6%, which corresponds to the value determined for current flow equal I_N. A reset of overload element is possible, when thermal state drops below 70%.

The run of presented characteristics is guaranteed up to the preset short-circuit multiplication of the short-circuit stage. If the short-circuit stage is switched off then the presented runs of characteristics are guaranteed up to the rated current multiplication amounting to 12. The conditions specified in: EN 60255-149 and EN 60947-4-1 standards are fulfilled.

HINT: If the power supply voltage of the OSC3 i ELBA100Am relay is turned off during the motor cooldown time which corresponds to the selected response curve (which is after the overload module was tripped), the countdown continues from the value at the power-off when the supply voltage is reconnected.

Table 4: Overload characteristic classes

Trigger-ing class	Triggering time T_p at the multiplication of the control circuit (for cold state)				Approximate time to switching on after the overload stage triggering in case of no flow of phase currents
	1,05	1,2	1,5	7,2	
2			$T_p \leq 48$ s	$0{,}5 < T_p \leq 2$ s	1:11
3			$T_p \leq 1{:}12$ min	$1 < T_p \leq 3$ s	1:47
5			$T_p \leq 2$ min	$2 < T_p \leq 5$ s	2:59
10A			$T_p \leq 2{:}48$ min	$3 < T_p \leq 7$ s	4:10
10			$T_p \leq 4$ min	$4 < T_p \leq 10$ s	5:58
15	$T_p \geq 2$ h	$T_p < 2$ h	$T_p \leq 6$ min	$5 < T_p \leq 15$ s	8:56
20			$T_p \leq 8$ min	$6 < T_p \leq 20$ s	11:55
25			$T_p \leq 10$ min	$7{,}5 < T_p \leq 25$ s	14:54
30			$T_p \leq 12$ min	$9 < T_p \leq 30$ s	17:53
35			$T_p \leq 14$ min	$11 < T_p \leq 35$ s	20:51
40			$T_p \leq 16$ min	$13 < T_p \leq 40$ s	23:50

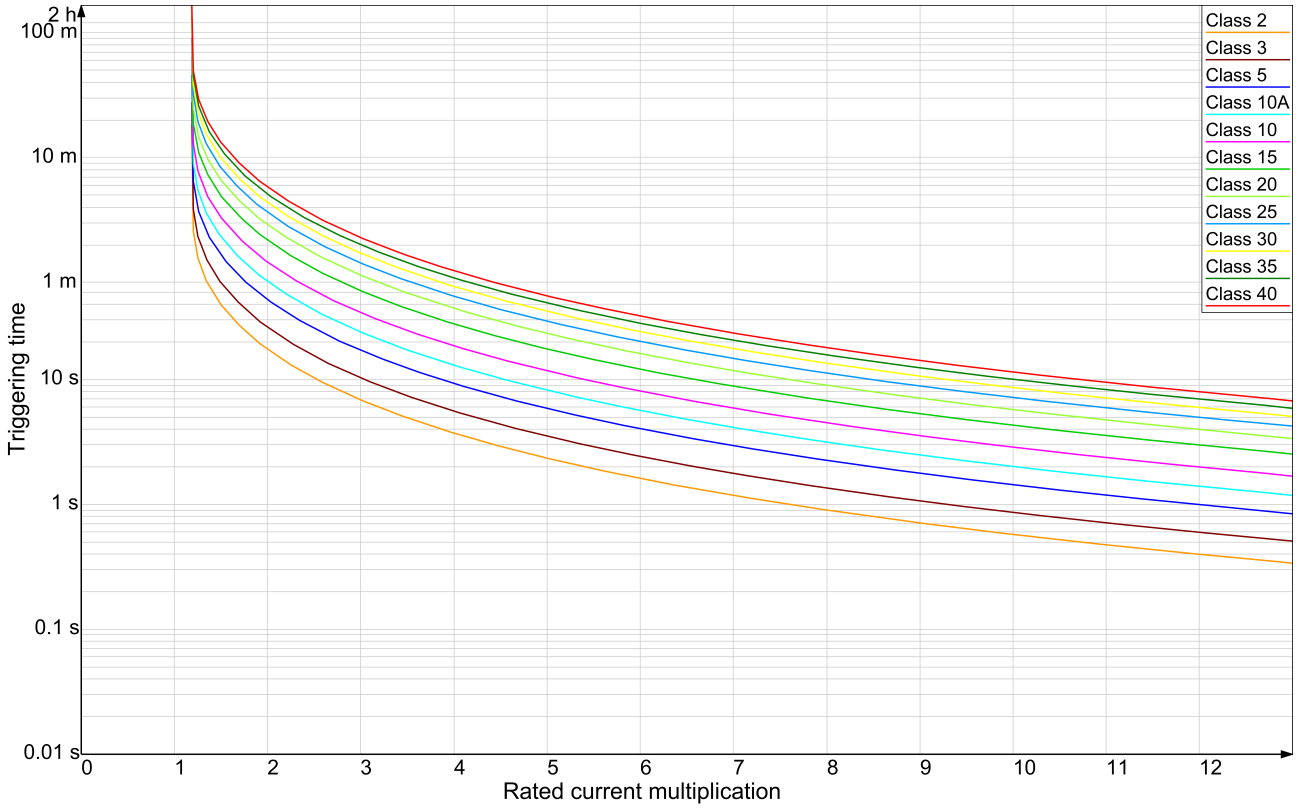


Figure 5: Class curves for cold state

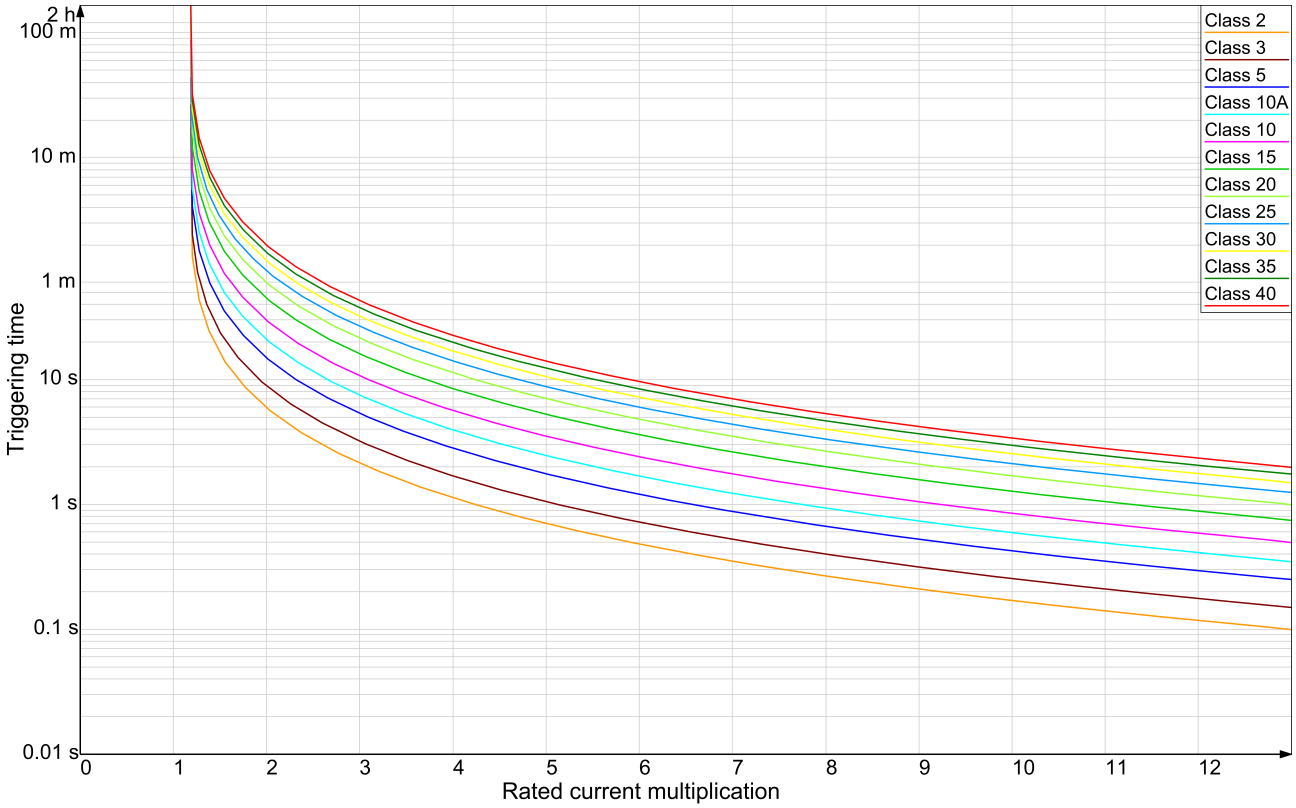


Figure 6: Class curves for hot state

17.2 Standard EN 60255-151

In overload element of the protection, also characteristics conforming EN 60255-151 standard have been implemented. Response and unlocking times are specified below. The given characteristics are marked in options acc. To the standard names specified in the standard. User can specify time constant for each curve. Its influence on characteristics is presented on figures from 7 to 12. Furthermore, user can specify own parameters of the user curve.

Response time:

$$t(I) = TMS\left(\frac{k}{\left(\frac{I}{I_n}\right)^a - 1} + c\right)$$

Unlocking time:

$$t(I) = TMS\left(\frac{t_r}{1-\left(\frac{I}{I_n}\right)^2}\right)$$

where:

I – forced current,

I_n – rated current,

t_r – unlocking time for $I = 0$ oraz $TMS = 1$,

TMS, k, a, c – parameters defined by standard.

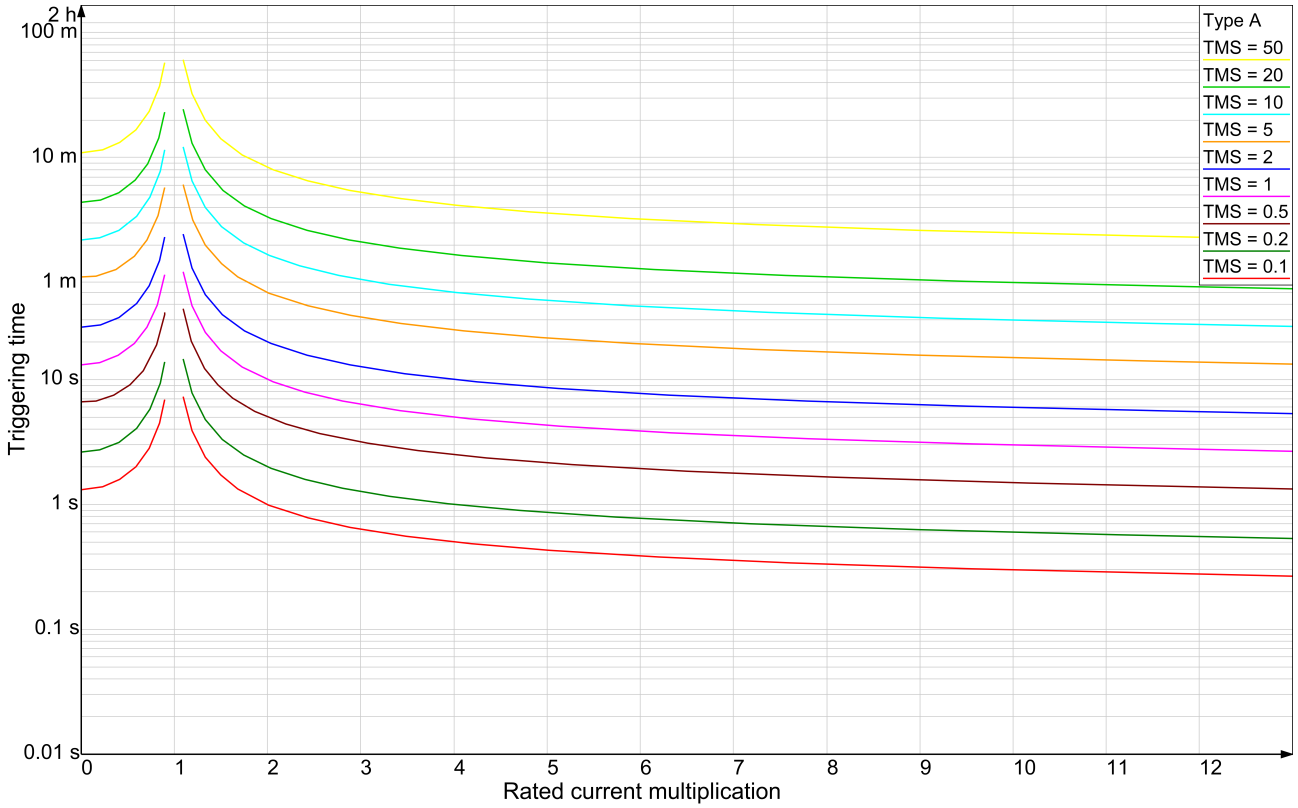


Figure 7: Characteristics type A (Inverse)

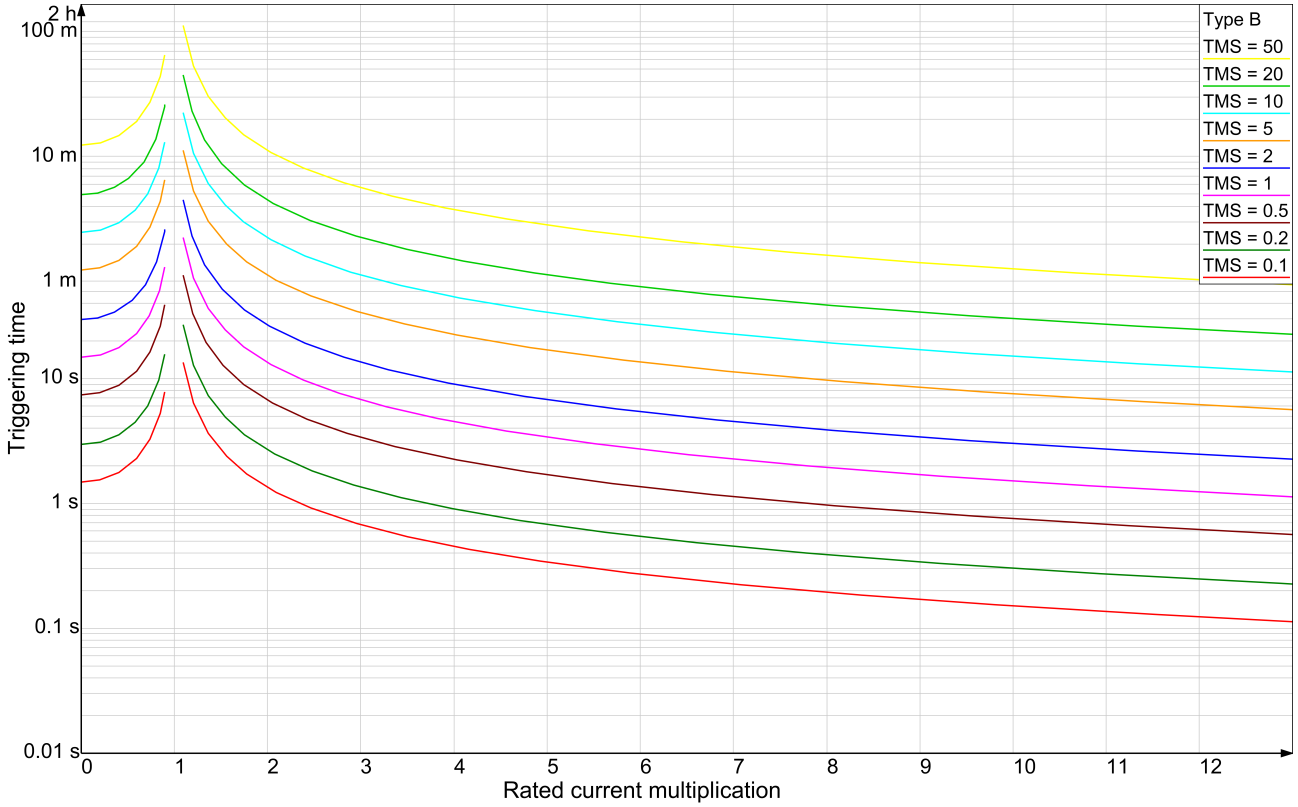


Figure 8: Characteristics type B (Very inverse)

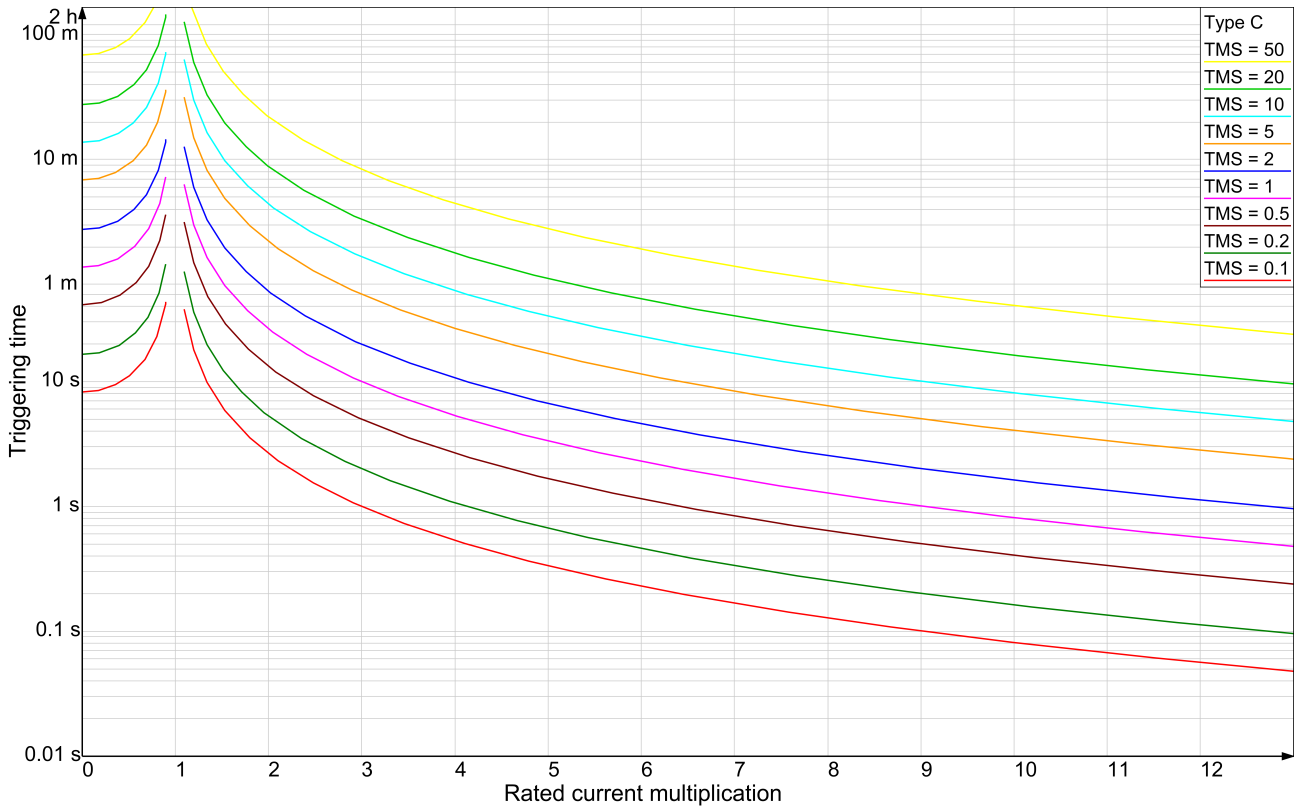


Figure 9: Characteristics type C (Extremely inverse)

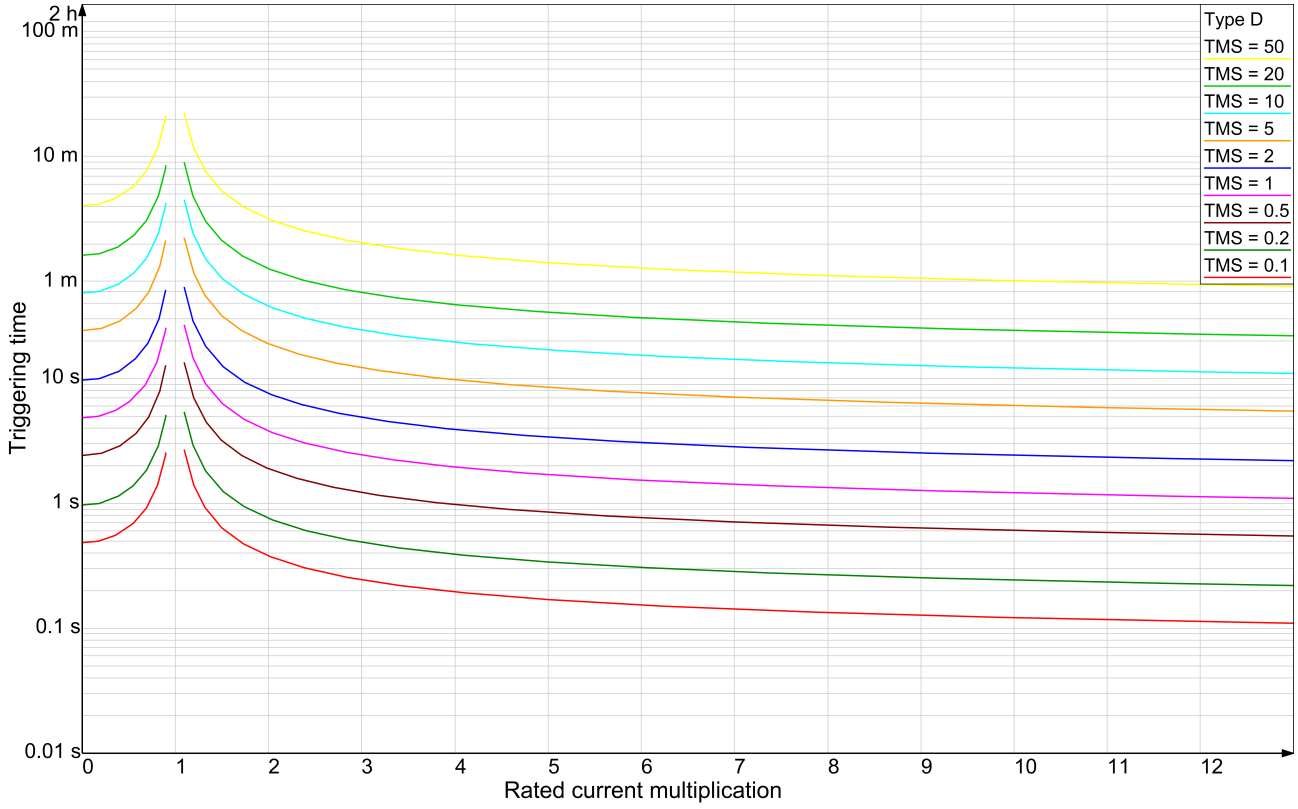


Figure 10: Characteristics type D (IEEE Moderately inverse))

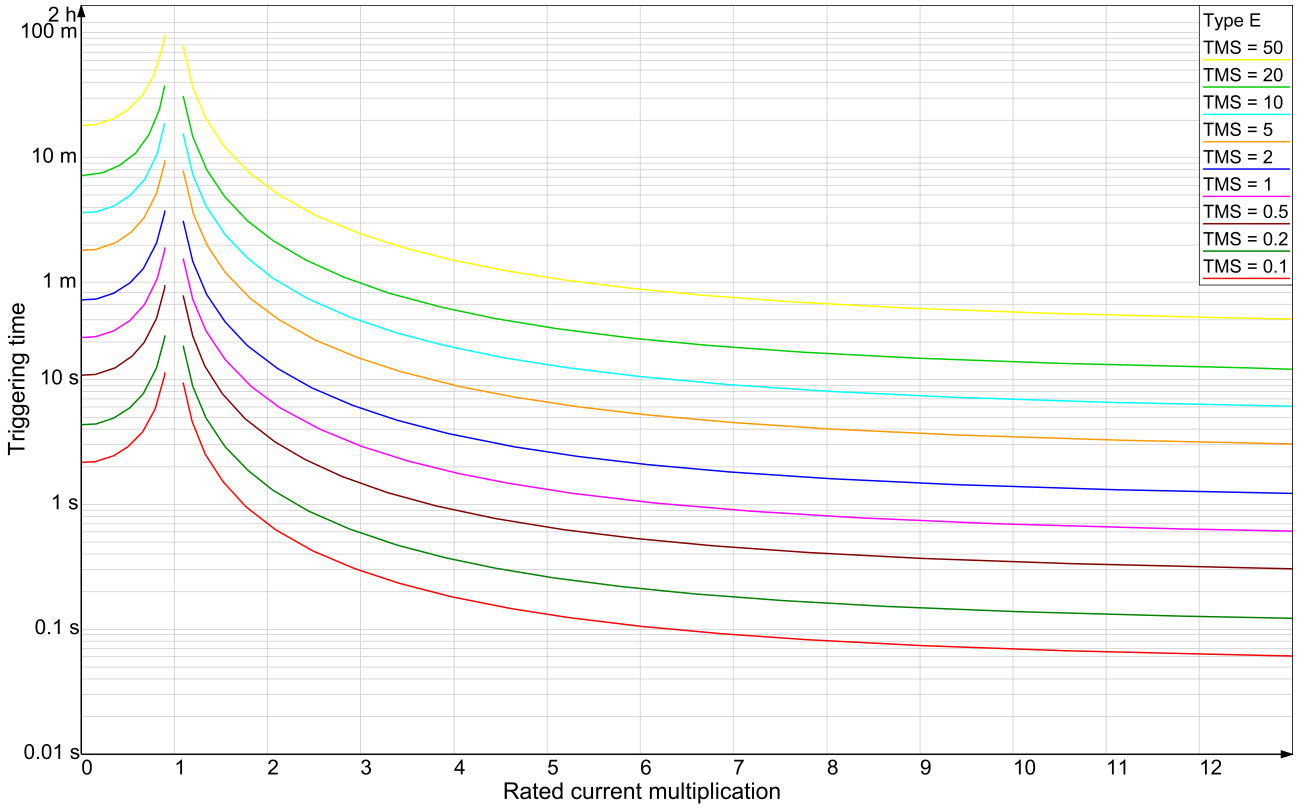


Figure 11: Characteristics type E (IEEE Very inverse)

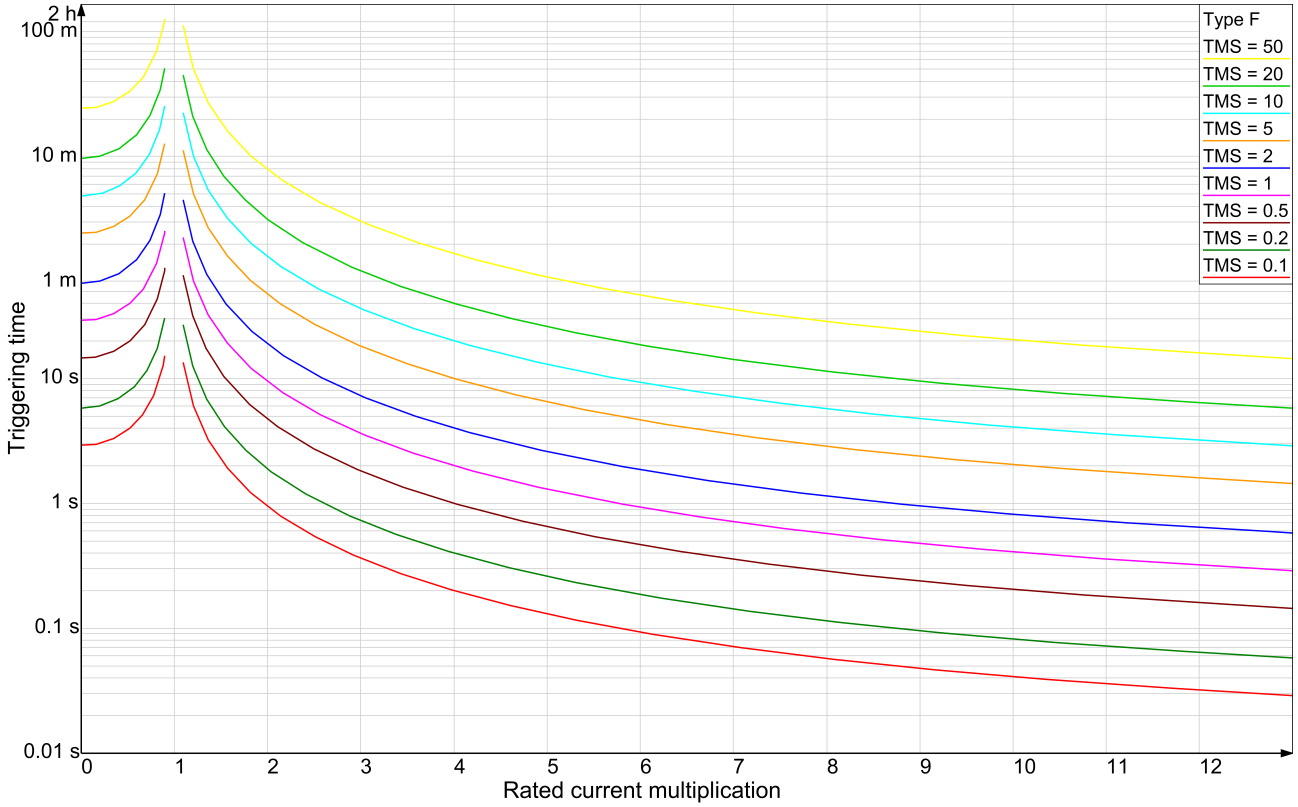


Figure 12: Characteristics type F (IEEE Extremely inverse)

17.3 Selecting of protection settings for motors with reinforced construction

A correct protection of a motor with reinforced construction „e" requires that the triggering time of the overload stage is shorter than t_E time of the protected motor. A class for which the overload stage triggering time is shorter than t_E motor time at motor starting current multiplication I_r/I_n should be selected from the overload and short-circuit characteristics.

A correct protection of a motor with reinforced construction „e" requires also that the time of switching off in case of short-circuit is shorter than 100ms. Taking into consideration the switch-off time of an average contact it is not recommended to set the short-circuit stage detection time to the value higher than 50ms.

18 Default configuration

The factory settings of the overload and short-circuit protection and possible ranges of settings are presented in the table 5. Default settings are applied in case when the protection restores the settings.

Table 5: Default configuration

Parameter	Adjustment range	Default value
Rated current / Rated current of the 2_{nd} gear	0.10…2A every 0.01A 2.0…10A every 0.05A 10…25A every 0.1A 25…100A every 0.5A 100…250A every 1A 250…1000A every 5A 1000…2500A every 10A *(remotely, optionally every 0.01 A)*	1A
Switching on control of 2_{nd} gear	Switched on or off	Switched off
Rated current of the 1_{st} gear	1% ÷ 1000%	50%
Current threshold of the 1_{st} gear for activation of 2_{nd} gear	20% ÷ 150% or switched off	110%
Switching off 1_{st} gear before activation of 2_{nd} gear	Switched on or off	Switched off
External control of 2_{nd} gear	Switched on or off	Switched off
Delay of activation of the 2_{nd} gear	1.0 s ÷ 60.0 s	5.0 s
Time of switching between the gears	0.1 s ÷ 10.0 s or switched off	0.5 s
Short-circuit multiplication of rated current	OSC3 – 2 ÷ 12, every 0.1 or switched off ELBA – 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 9, 10, 11, 12 or switched off	3
Short-circuit stage detection time	20 ms ÷ 1000 ms, every 5 ms	40 ms
Constant component filter	Switched on or switched off	Switched on
Current ratio	0.1 ÷ 250 mV/A, co 0.1mV/A	5 mV/A

Parameter	Adjustment range	Default value
Types of overload characteristics	Classes 2, 3, 5, 10A, 10, 15, 20, 25, 30, 35, 40, Type A (Inverse), Type B (Very inverse), Type C (Extremely inverse), Type D (IEEE Moderately inverse), Type E (IEEE Very inverse), Type F (IEEE Extremely inverse), User	Class 5
Method of overload stage triggering state reset	Manual or automatic	Manual
Control stage mode	Pulsed or continuous	Pulsed
Duration time of the control advance signal	1 ÷ 240 s or switched off, co 1s	5 s
Waiting time for the control acknowledgment signal	0.1 ÷ 2.5 s or switched off, every 0.1s	1.5 s
Method of external errors reset	Manual or automatic	Manual
External Reset works as Stop	Switched on or switched off	Switched off
Maximal allowed asymmetry	10 ÷ 60% or switched off, every 1%	10%
Asymmetry stage detection time	0.02 s ÷ 99.90 s	4.00 s
Relays configuration	Assignment to the signals: I>>, I>, As, R, A, NA, T>, PE, H, AEr, 2Er, ⏚C, ⏚B, CA, C/1, 2, A, Rst	K1 – I», I>, As K2 – I», I>, As, NA, T>, PE, H, AEr, 2Er, ⏚CB K3 – CA K4 – C K5 – A
Inputs configuration	Assignment to the signals: Rst, PE, R, A, T>, H, NA, ⏚C, ⏚B, 2	I0 – Rst I1 – A I2 – H I3 – R I4 – NA I5 – PE I6 – T> I7 – ⏚B
Access passwords	00000000 ÷ 99999999	00000000
Display backlight	Switched on or switched off	Switched on
Idle period after which the menu will be quitted automatically	1 ÷ 10 minutes, every 1 minute	2 minutes
User interface language	Polish, English, German, Spanish, Czech, Russian, Turkish	Polish
Device address	1 ÷ 247	247
Transmission rate	300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 14400, 19200, 28800, 38400, 57600, 115200 bps	19200 bps
Number of stop bits	1, 1.5, 2	1
Parity	Even, odd, zero, one, none	Even
Coefficient „TMS”	0.01 ÷ 50	1
Coefficient „k”	0.01 ÷ 100	1
Coefficient „tr”	0.01 ÷ 250	1

Parameter	Adjustment range	Default value
Coefficient „c”	0.00 ÷ 2	1
Coefficient „a”	0.01 ÷ 2.5	1

19 Modbus

The overload and short-circuit protection enables a remote access to the measuring and configuration data through the Modbus protocol, in RTU mode, with using of RS–485 physical interface.

The communication method and the specification of the Modbus protocol functions for the OSC3 i ELBA100Am are shown in a separate document titled „Overload and Short-Circuit protections for 3-phase outlets OSC3 i ELBA100Am type : Modbus communication protocol'', no. BP/IOM/04/09.

20 Conformity with standards

The design engineering of this product was based on the standards listed in Table 6:

Table 6: Reference standards

Standardization document	Description
Directive 2014/30/EU	**Electromagnetic Compatibility (EMC)**
PN-EN IEC 61000-6-2:2019-04 *(EN IEC 61000-6-2:2019)*	Electromagnetic compatibility (EMC). Part 6-2: Generic standards. Immunity for industrial environments.
PN-EN IEC 61000-6-4:2019-12 *(EN IEC 61000-6-4:2019)*	Electromagnetic compatibility (EMC). Part 6-4: Generic standards. Emission standard for industrial environments.
Directive 2014/35/EU	**Low Voltage Directive (LVD)**
PN-EN 60947-1:2010/A2:2014-12 *(EN 60947-1:2007/A2:2014)* *(IEC 60947-1:2007/AMD2:2014)*	Low-voltage switchgear and controlgear. Part 1: General rules.
PN-EN IEC 60947-4-1:2019-05 *(EN IEC 60947-4-1:2019)*	Low-voltage switchgear and controlgear. Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters.
PN-EN ISO 13849-1:2016-02 *(EN ISO 13849-1:2015)*	Safety of machinery – Safety-related parts of control systems. Part 1: General principles for design.
PN-EN 60529:2003/A2:2014-07 *(EN 60529:1991/A2:2013)*	Degrees of protection provided by enclosures (IP Code).
Other	
PN-EN 60255-149:2014-03 *(EN 60255-149:2013)*	Measuring relays and protection equipment. Part 8: Functional requirements for thermal electrical relays.
PN-EN 60255-151:2010 *(EN 60255-151:2009)*	– Measuring relays and protection equipment. Part 151: Functional requirements for over/under current protection.
PN-EN 62061:2008/A2:2016-01 *(EN 62061:2005/A2:2015)* *(IEC 62061:2005/AMD2:2015)*	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.
PN-EN 50495:2010 *(EN 50495:2010)*	Safety devices required for the safe functioning of equipment with respect to explosion risks.

21 End notes

EXPROTEC is the manufacturer of this product and reserves the right to changes and modifications as a result of technical progress and to use equivalent replacement parts.

This product has been manufactured in compliance with good engineering practices.

22 Orders and service

The orders should be sent to the following address:

EXPROTEC Sp. z o.o.
43-100 Tychy, ul. Graniczna 26A
Poland
Phone/fax:
+48 32 326 44 00
+48 32 326 44 03
Internet:
biuro@exprotec.pl
www.exprotec.pl

The housing components are replaced by the manufacturer or a company authorized by the manufacturer.

The manufacturer is not responsible for the device quality in case of repairs or components replacement made by the customer itself.

The manufacturer reserves the right to make changes in this specification in any time, without the necessity to inform about it.

EXPROTEC

EXPROTEC company protects people and environment by the safety of its components, systems and devices.

EXPROTEC company develops and produces the innovative components and systems which are controlled in accordance with international standards and are applied in areas endan-gered by explosion as well as in the field of environment pro-tection, radioactive protection and industry.