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Capacitor protection relay

ESTAsym MD

Operating instructions

QUALITY MANAGEMENT
Certified by VDE according to
DIN EN ISO 9001
Reg. No. 2556/QM/03.94

Revision history

Date	Name	Revision	Change
25.08.11	drt	00	initial document release
20.12.11	brm	01	update of content
07.05.12	fez	02	corrections

Content

1 Characteristics

The microprocessor-based capacitor protection relay ESTAsym MD is a versatile integrated current measuring multi-function relay design, to be used for the protection of medium and high voltage capacitor banks. Through the use of FFT techniques the ESTAsym MD extracts from measured line and unbalance currents the currents of fundamental frequency and harmonics currents. From this results are calculated the values used for the individual protective functions.

The capacitor protection relay can be used especially in capacitor banks connected in double wye and H configuration. Protective functions provided by the ESTAsym MD are the following:

- Capacitor unbalance protection
- Line current unbalance protection
- Overvoltage protection
- Overheating protection
- Ground fault protection
- Fundamental harmonic and RMS - overcurrent protection
- Undercurrent protection
- Capacitor bank discharge timer

2 Description of function

2.1 Capacitor Unbalance Protection

The protection measures fundamental frequency of the natural unbalance current of capacitor bank and compensates it for both amplitude and phase to zero, to enable detection of further changes, in both amplitude and phase angel. Phase current input I_{L1} is used as synchronizing input for the compensation. The phase angel indicates the leg in which the change in capacitance has occurred. The indication of failed leg depends of the fact whether the capacitors have element fuses or not (Fig. 6 and 7).

The protection has two-stages, warning and tripping, both with adjustable definite timer. A trip signal is output if associated threshold is exceeded for the definite time set. ESTAsym MD compares the stored unbalance value with present phase-current.

2.2 Line Current Unbalance Protection

The protection calculates the fundamental frequency line current unbalance due to faults or failures within the capacitor bank. The line current unbalance is calculated from 3-phase line currents. The protection includes two-stages, warning and tripping, both with adjustable definite timer. A trip signal is output if value of the line unbalance current exceeds the selected set point value for the definite time.

2.3 Overvoltage Protection

The purpose of the overvoltage protection is to protect the capacitor bank against overload due to fundamental and harmonics currents, which may lead to dielectric breakdown, i.e. short-circuit in a capacitor element. The capacitor bank voltage is calculated from 3-phase line fundamental frequency component current and from harmonic currents. Overvoltage factor is calculated and continuously compared with a variable threshold. It is possible to choose between definite time characteristic and an inverse time characteristic according to ANSI–curve. A trip signal is output if the set point value is exceeded for the definite time.

2.4 Overheating Protection

Overheating protection stage is intended to be used for protection of serial reactance coils used within capacitor banks. This protection is based on measuring the RMS 3-phase line currents and comparing them with an adjustable threshold. The protection has either two stages, warning and tripping, both with adjustable definite-time delay, or it is possible to select tripping time depending on the ratio of the actual current to the nominal current. Warning time is half of tripping time. If the current exceeds the relevant set point value for the definite-time delay, tripping or warning signal is output. The protection has two ANSI modes and tripping time adjusting.

2.5 Ground Fault Protection

The protection calculates the fundamental frequency ground fault current, as the value of the vector sum of the 3-phase line currents. The protection has two-stages, warning and tripping, both with adjustable definite time. A trip signal is output if amplitude of the ground fault current exceeds the selected set point value for the definite time.

2.6 Fundamental Harmonic Overcurrent Protection

The protection stage is measuring the fundamental frequency of 3-phase currents and comparing them with an adjustable threshold. This function may be used for short circuit protection. A trip signal is output if the value of the line current exceeds the selected set point value for the definite time. The protection has two adjustable threshold values, each with separately adjustable time delay.

2.7 RMS – overcurrent Protection

The protection calculates RMS value of 3-phase currents and comparing them with an adjustable threshold. The protection has two adjustable threshold values, each with separately adjustable time delay.

2.8 Undercurrent Protection

The undercurrent protection is intended for the detection of capacitor bank disconnection. In case of voltage loss in the feeding bus, the capacitor bank has to be disconnected from the system to prevent reapplication of the voltage on the capacitors before they are fully discharged. The stage starts when one of the three phase currents falls below the set level. If the undercurrent condition persists for a time longer than the set operating time, the trip signal is output. The auxiliary contact of circuit breaker signals to ESTAsym MD if the circuit breaker is off or a black-out occurred. The blocking-relay contact operates together with the tripping contact. The closure time of blocking relay is given by the preset blocking time.

2.9 Capacitor Bank Discharge Timer

The relay includes an adjustable timer, started by the circuit breaker auxiliary contacts, which blocks the breaker reclosing until the capacitor bank is discharged to an acceptable voltage level for switching in. ESTAsym MD has an auxiliary contact for this purpose. It is possible to adjust the timer from 2s to 10 min step 1s.

3 Matching of protective function

Block or release of protection functions: By clicking the fields Enabled in the parameterization program it is possible to enable or disable individual protection functions.

Matching of protective function	
Connection of capacitor bank	**Protective function**
Double wye with reactors	Capacitor unbalance protection Line current unbalance protection Overvoltage protection Overheating protection Ground fault protection Fundamental harmonic overcurrent protection RMS - overcurrent protection Undercurrent protection Capacitor bank discharge timer
Double wye without reactors	Capacitor unbalance protection Line current unbalance protection Overvoltage protection Ground fault protection Fundamental harmonic overcurrent protection RMS - overcurrent protection Undercurrent protection Capacitor bank discharge timer
H3- Bridge with and without reactors	Capacitor unbalance protection Capacitor bank discharge timer
H1- Bridge with reactors	Capacitor unbalance protection Overvoltage protection Overheating protection Fundamental harmonic overcurrent protection RMS - overcurrent protection Undercurrent protection Capacitor bank discharge timer
H1- Bridge without reactors	Capacitor unbalance protection Overvoltage protection Fundamental harmonic overcurrent protection RMS - overcurrent protection Undercurrent protection Capacitor bank discharge timer
Triple double wye	Capacitor unbalance protection Capacitor bank discharge timer

4 Block diagram ESTAsym MD

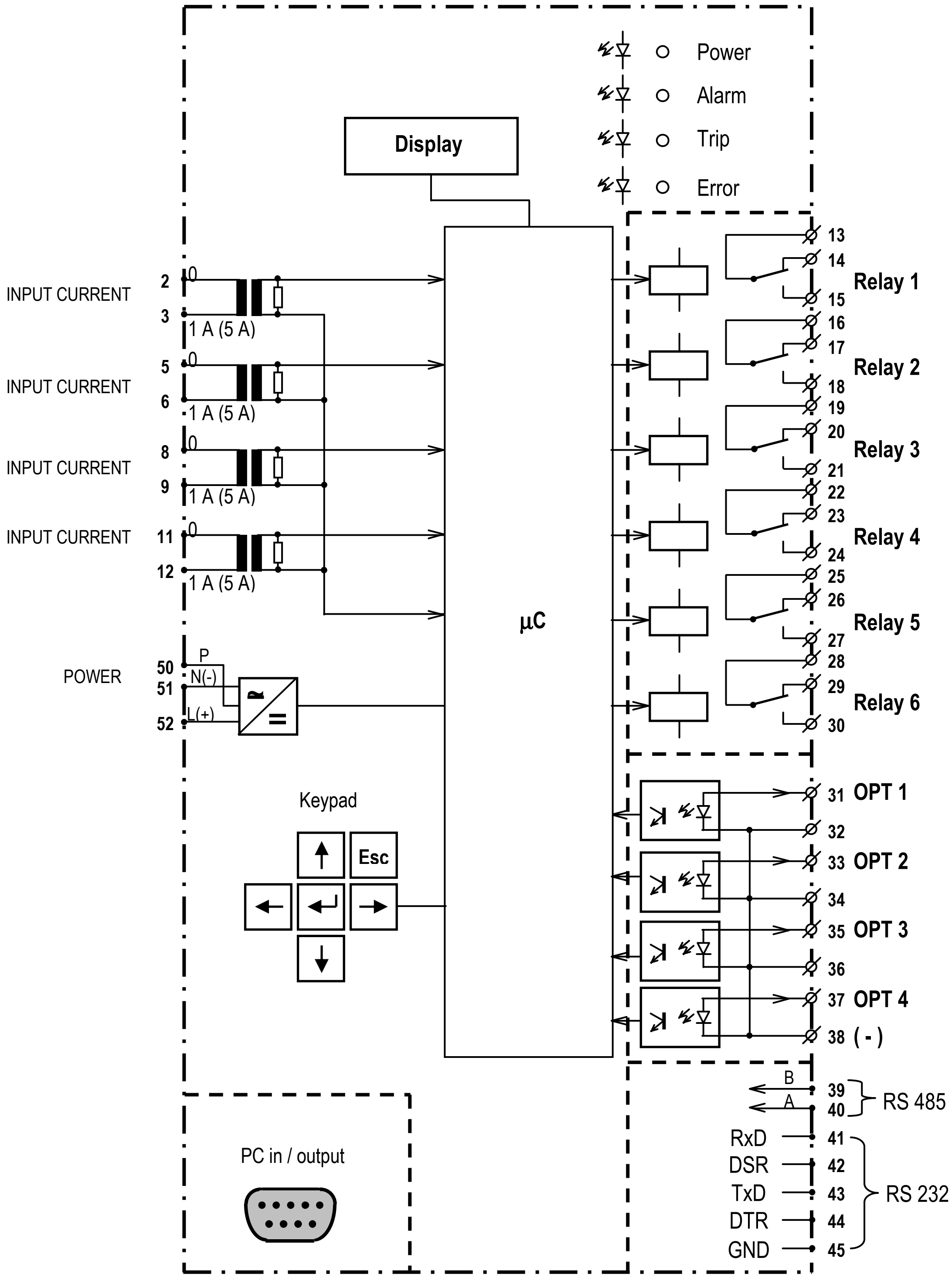


Fig.1 Block diagram ESTAsym MD

5 Current inputs

Four current inputs are provided within ESTAsym MD. Each can be parameterized to 1A or 5A.

Matching of inputs	
Connection of capacitor bank	**Inputs**
Double wye	Input 1 – Line current L1 Input 2 – Line current L2 Input 3 – Line current L3 Input 4 – Unbalance current
H- Bridge; Triple double wye	Input 1 – Line current L1 Input 2 – Unbalance current 1 Input 3 – Unbalance current 2 Input 4 – Unbalance current 3

For phase currents, the current transformer ratio can be set to 10-3000/1A or /5A. The device evaluates phase currents up to 6000A. The transforming ratio for unbalance current can be set to 1-100/1A or /5A.

6 Optron inputs

The OPT 1 and OPT 2 are used for Capacitor Bank Discharge Timer. This function is started by the circuit breaker auxiliary contact wired to one of Optron inputs. OPT 3 and 4 are reserve. Input voltage can be in the range from 20 to 220 V DC.

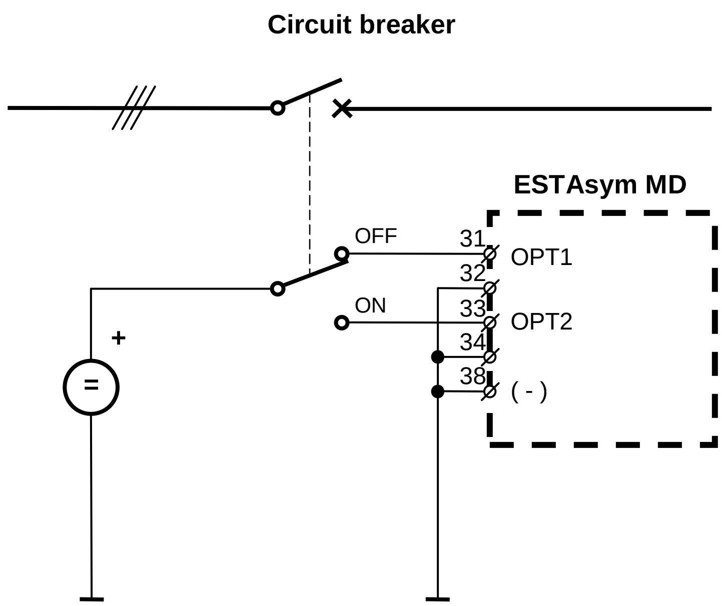


Fig.2 Wiring of optocouplers

7 LCD display

Two lines, 16 character and full alpha-numeric LCD display (Fig.3) is provided on the front panel for the following purposes:

- During normal relay operation:
  Display of various measured parameters together with the threshold and times associated with these parameters
- During relay configuration:
  Interactive configuration of protection relay
- After warning or tripping:
  Recording of fault currents and voltages at the instant of warning or tripping

8 Keypad

A six button key-pad is provided on the front panel (Fig.3) of relay for the following purposes:

- Interactive configuration of the protection relay
- Acknowledgement and resetting of trip conditions

9 Relay outputs

ESTAsym MD has six relay outputs:

- Relay 1, 2, 3, 4 and 6: optional protection function
- Relay 5 is self-monitoringsupervision relay

The user may program the relays to be manual or self-resetting, and to be normally energized or de-energized during the power-up healthy condition.
All output relays have a full change – over contact. All N/O and N/C contact are permanently wired to the terminal block.

10 LED indicators

Four LED indicators are provided on the front panel (Fig.3) of relay, as follow:

- Green LED – Power ON /Healthy, this indicates that the auxiliary power supply is on
- Red LED – Warning, this indicates that the threshold values for warning (is) are exceeded

- Red LED – Trip – this indicates that the threshold values for tripping (is) are exceeded
- Red LED – Error – this indicates fault of protection relay

Fig.3 Front panel ESTAsym MD

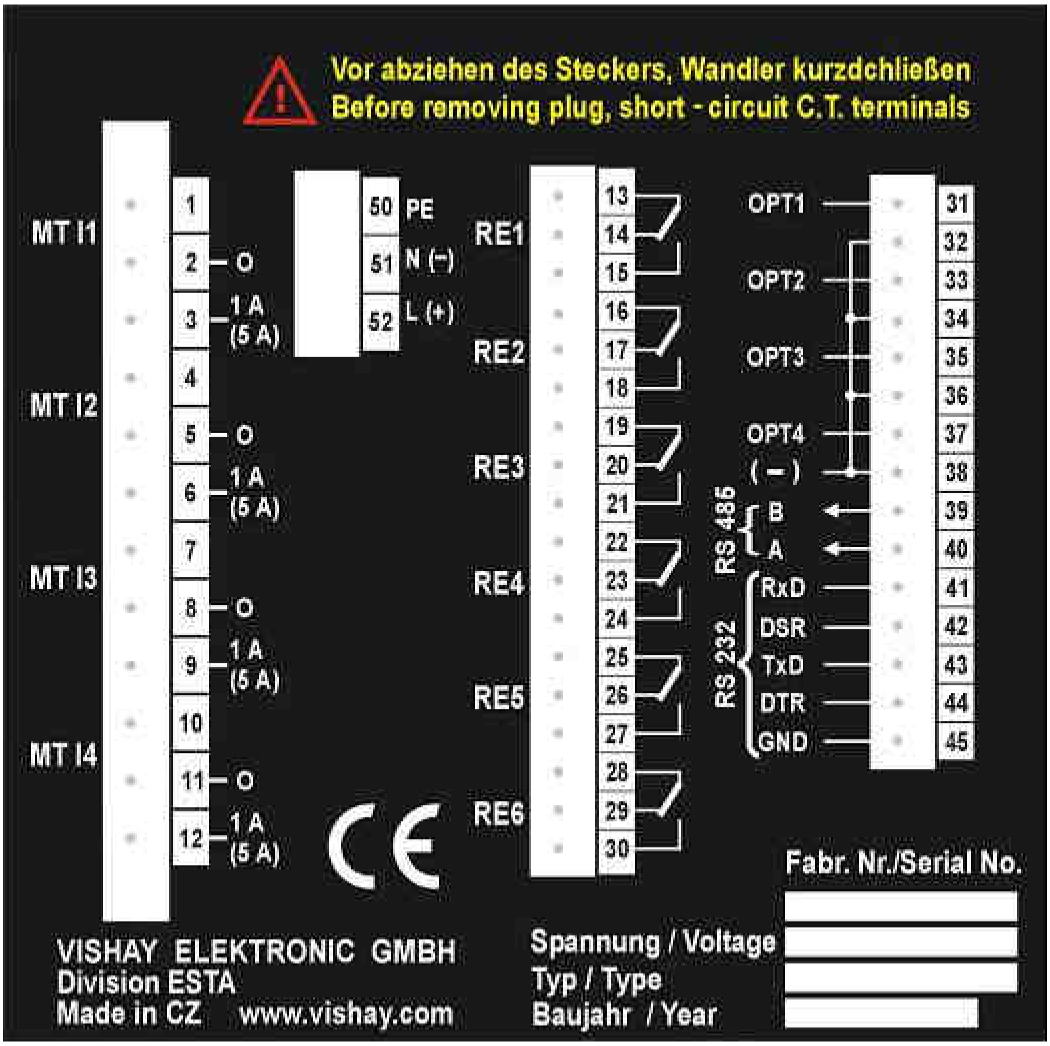


Fig.4 Rear panel

11 Boot– Loader Software update

Boot–Loader is means for updating ESTAsym MD software using RS232 interface. This function is provided only by the producer.

12 Settings

Parameter setting ESTAsym MD		
Protection	**Parameter**	**Setting range**
Capacitor unbalance	Warning threshold Tripping threshold Lower threshold I_u Lower threshold I_{L1}	I_u 0,1 -100A Delay 0,1 - 6 s I_u 0,1 -100A Delay 0,1 - 6 s I_u 0,01 – 1 A in A, (5% - 30%)I_{L1}
Line current unbalance	Warning threshold Tripping threshold Nominal current	1 - 30% I_n Delay 0,3 – 6s 2 - 30% I_n Delay 0,3 – 6s I_n 10 - 3000A
Overvoltage	**IEC(ANSI):** Overvoltage factor Phase capacitance Nominal voltage (Line to Line) **Set time:** Overvoltage factor Nominal voltage (Line to Line)	 0,8; 0,9; 1,0; 1,10; 1,25; 1,50 1 - 6400 µF 2 - 450 kV 0,8 – 2,0 Delay 0,1 - 6 s 2 - 450 kV
Overheating	Warning threshold Tripping threshold	10 - 6000 A 10 - 6000 A **Set time on:** Delay warning 1 - 7200 s Delay tripping 1 - 7200 s **Set time off:** The time sink with the ratio actual current/nominal current. Warning time is always a half of tripping time
Ground fault	Warning threshold Tripping threshold Nominal current	1 - 30% I_n Delay 0,3 – 6 s 1 - 30% I_n Delay 0,3 – 6 s I_n 10 – 3000 A
Fundamental harmonic overcurrent protection RMS – overcurrent protection	Tripping threshold Tripping threshold	10 – 6000 A Delay 0,1 - 6 s 10 – 6000 A Delay 0,3 - 6 s
Undercurrent	Tripping threshold	10 – 3000 A Delay 0,3 - 6 s
Capacitor bank discharge timer		Delay from 2s to 10min step 1s

Legend:

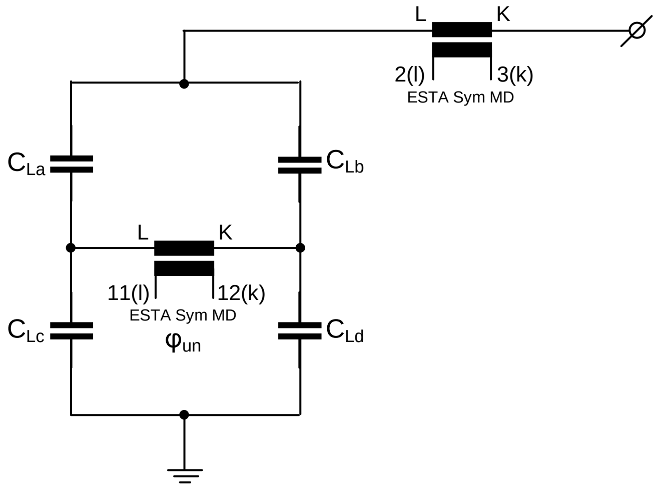
- Lower threshold I_u: The minimum value of unbalance current for compensation natural unbalances current. For the current input 1A I_u = 5mA, for 5A I_u = 25mA (value of secondary CT winding).
- Lower threshold I_{L1}: The minimum value of phase L_1 current that the protection relay accepts. The values are the same as by I_u.
- Overheating – set Time: If inactive - the tripping time depends on the ratio actual current/nominal current.
- All current values refer to the primary side of current transformers.
- All parameters of all functions are compared with each other to provide reliable operation of protection.
- With regard to network voltage fluctuation are the adjusted thresholds for Warning (I_W) and Tripping (I_T) recalculated to values I'_W or I'_T according to following equation:

  $I'_{W(T)} = 0.8 \cdot I_{W(T)}$ ……. für $(I_{L1}/I_N) \leq 0,8$;

  $I'_{W(T)} = (I_{L1}/I_N) \cdot I_{W(T)}$ … für $0,8 < (I_{L1}/I_N) < 1,2$;

  $I'_{W(T)} = 1.2 \cdot I_{W(T)}$ ……. für $(I_{L1}/I_N) > 1,2$.

Fig. 5a Capacitor bank in H-Bridge with failure



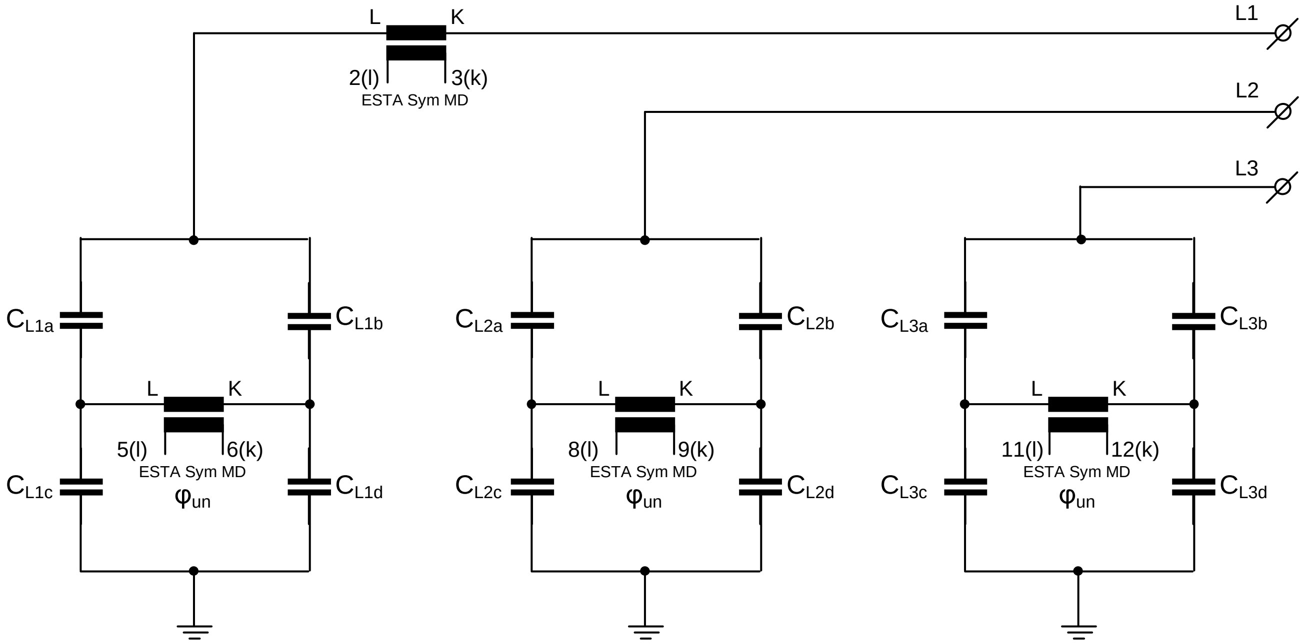
1.) Failed element in the capacitor unit with element fuses

Phase angel φ_{unb}	**Faulty capacitor unit**
0°	C_{La} or C_{Ld}
180°	C_{Lc} or C_{Lb}

2.) Failed element in the capacitor unit without element fuses

Phase angel φ_{unb}	**Faulty capacitor unit**
0°	C_{Lc} or C_{Lb}
180°	C_{La} or C_{Ld}

Fig. 5b Capacitor bank in 3H-Bridge with failure



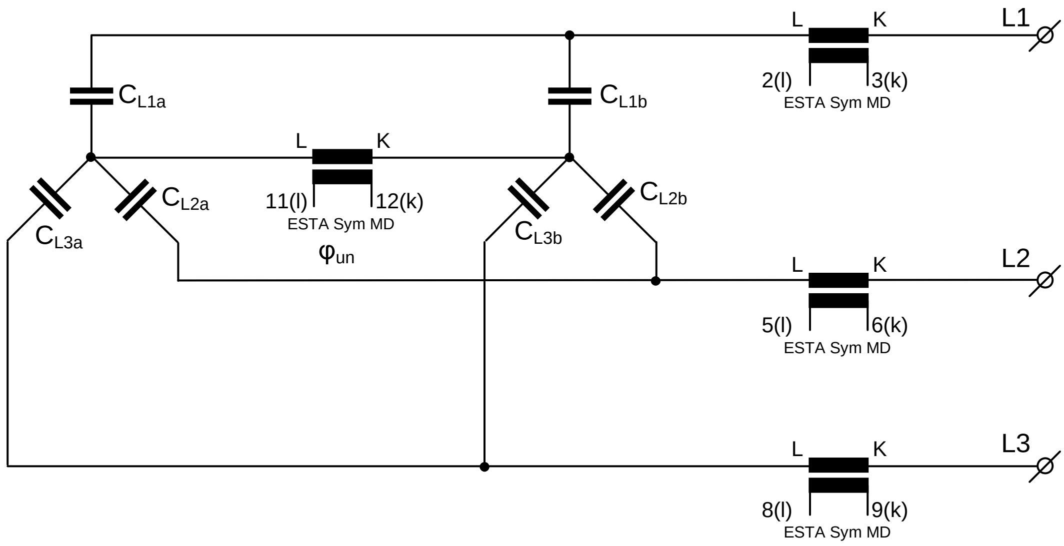
1.) Failed element in the capacitor unit with element fuses

Phase angel **φ_{unb}**	**Faulty capacitor unit**
0°	C_{L1a} or C_{L1d}
60°	C_{L3c} or C_{L3b}
120°	C_{L2a} or C_{L2d}
180°	C_{L1c} or C_{L1b}
240°	C_{L3a} or C_{L3d}
300°	C_{L2c} or C_{L2b}

2.) Failed element in the capacitor unit without element fuses

Phase angel **φ_{unb}**	**Faulty capacitor unit**
0°	C_{L1c} or C_{L1b}
60°	C_{L3a} or C_{L3d}
120°	C_{L2c} or C_{L2b}
180°	C_{L1a} or C_{L1d}
240°	C_{L3c} or C_{L3b}
300°	C_{L2a} or C_{L2d}

Fig. 6a CAPACITOR BANK IN DOUBLE WYE WITH FAILURE



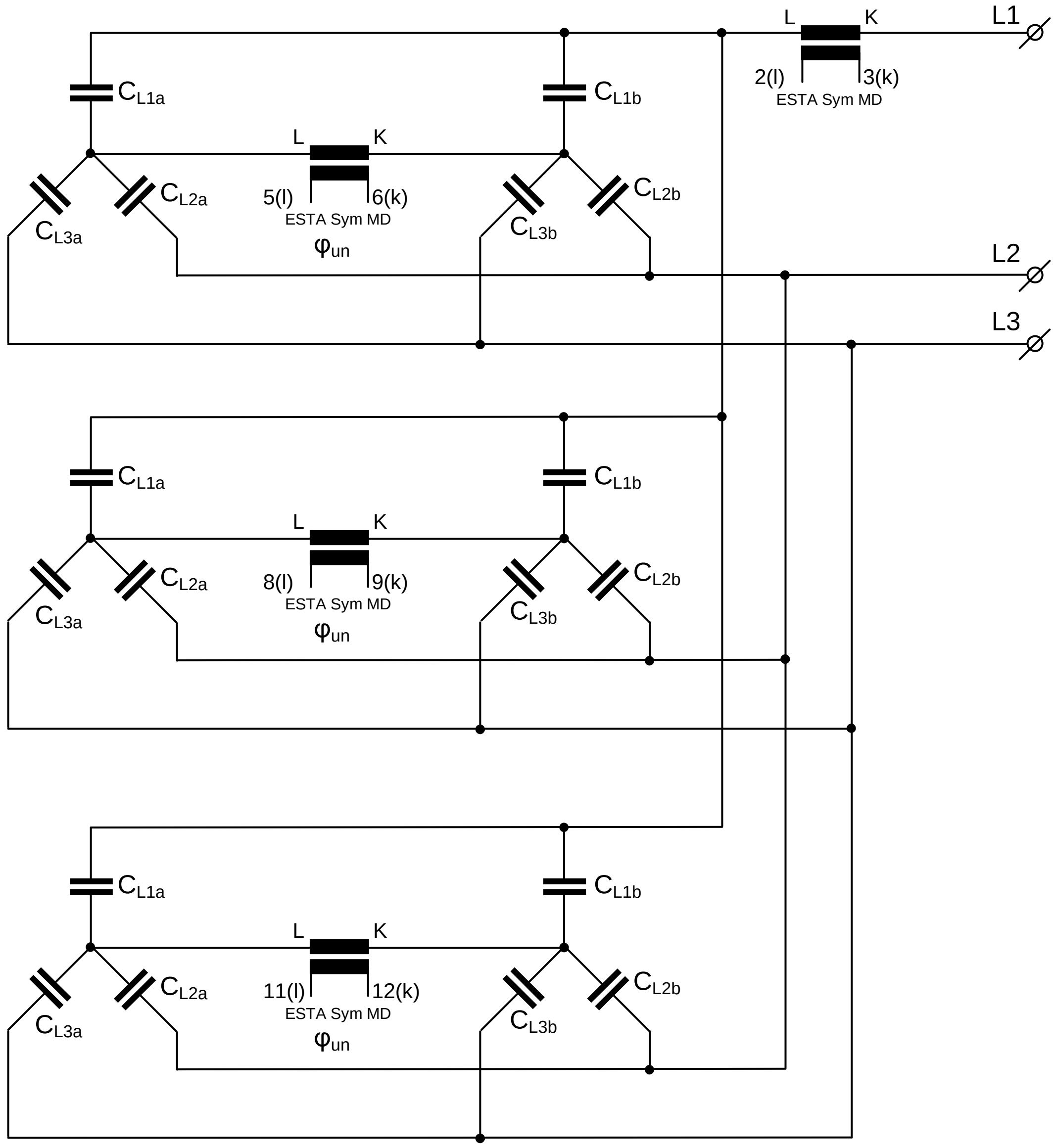
1.) Failed element in the capacitor unit with element fuses

Phase angel φ_{unb}	Faulty capacitor unit
0°	C_{L1b}
60°	C_{L3a}
120°	C_{L2b}
180°	C_{L1a}
240°	C_{L3b}
300°	C_{L2a}

2.) Failed element in the capacitor unit without element fuses

Phase angel φ_{unb}	Faulty capacitor unit
0°	C_{L1a}
60°	C_{L3b}
120°	C_{L2a}
180°	C_{L1b}
240°	C_{L3a}
300°	C_{L2b}

Fig. 6b CAPACITOR BANK IN TRIPLE DOUBLE WYE WITH FAILURE



1.) Failed element in the capacitor unit with element fuses

Phase angel φ_{unb}	Faulty capacitor unit
0°	C_{L1b}
60°	C_{L3a}
120°	C_{L2b}
180°	C_{L1a}
240°	C_{L3b}
300°	C_{L2a}

2.) Failed element in the capacitor unit without element fuses

Phase angel φ_{unb}	Faulty capacitor unit
0°	C_{L1a}
60°	C_{L3b}
120°	C_{L2a}
180°	C_{L1b}
240°	C_{L3a}
300°	C_{L2b}

12.1 Example of parameter setting ESTAsym MD

Parametrs of capacitor bank:

Capacitor Bank	4 MVAr, double wye
Nominal line to line voltage	U_n =11 kV
Nominal line current	I_n = 231 A
Phase capacity	C_n = 127,3 µF
Unit nominal voltage	U_n = 6,35 kV, (Line to line voltage 11 kV)
Unit capacity	C_n = 31,8µF
Double wye with reactors	

ESTAsym MD settings:

Double wye with reactors
Nominal current 231 A
Network frequency 50Hz
Current transformer ratio: I_{L1} 1000/5; I_u 20/5

Unbalance protection:

Warning threshold 0,8A; Delay 5s; Output relay RE1;
Tripping threshold 2A, Delay 0,3s; Output relay RE2;
Lower threshold I_{L1} 50A
Lower threshold I_u 0,1 mA

Overvoltage protection:

Overvoltage factor: 1,25
Phase capacitance: 127,3 µF
Line to line Voltage: 11 kV
(If set time and delay are empty, will be used ANSI-curve according to the paragraph 17)
Tripping: Output relay RE2;

Excessive heating protection:

Warning threshold 240 A, Delay 300s; Output relay RE1;
Tripping threshold 50 A, Delay 600s; Output relay RE2;
(If set time and delay are empty, will be used ANSI-curve according to the paragraph 18)

Line current unbalance protection:

Warning threshold 10%; Delay 1s; Output relay RE1;
Tripping threshold 30%; Delay 1s; Output relay RE2;

Ground current:

Warning threshold 10 %, Delay 1s; Output relay RE1;
Tripping threshold 20 %, Delay 1s; Output relay RE2;

Undercurrent protection:

Tripping threshold 10 A, Delay 0,3s; Output relay RE2;

<u>Fundamental harmonic overcurrent protection:</u>

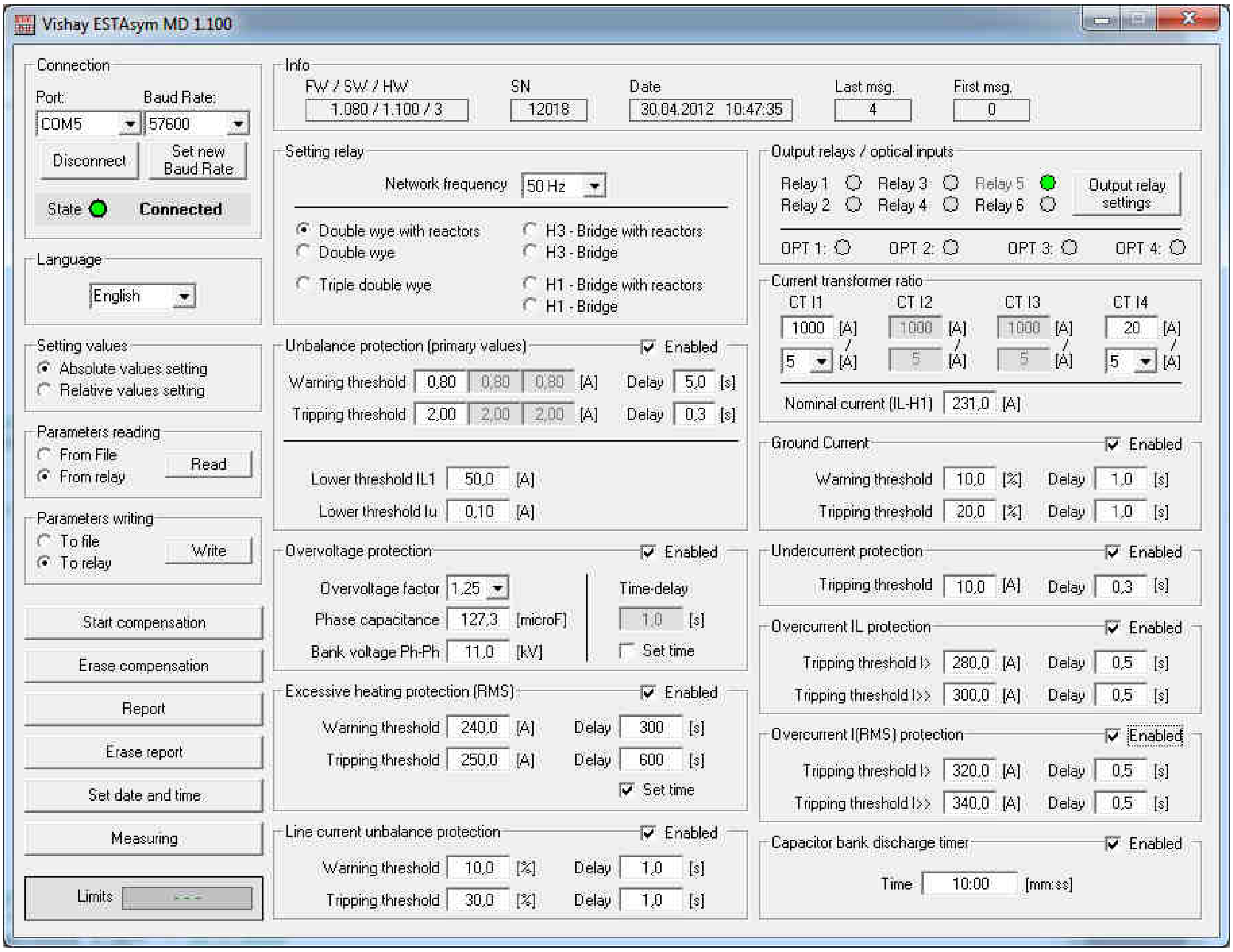
Tripping threshold I> 280 A; Delay 0,5s; Output relay RE2;
Tripping threshold I>> 300 A; Delay 0,5s; Output relay RE2;

<u>Overcurrent protection I(RMS):</u>

Tripping threshold I> 320 A; Delay 0,5s; Output relay RE2;
Tripping threshold I>> 340 A; Delay 0,5s; Output relay RE2;

<u>Capacitor bank discharge timer:</u> 10 min; Output relay RE4;

<u>Breaker failure:</u> Output relay RE3;



<u>Output relay settings:</u>

Inverse Funktion: unused;

RE1: Mode - ACK;

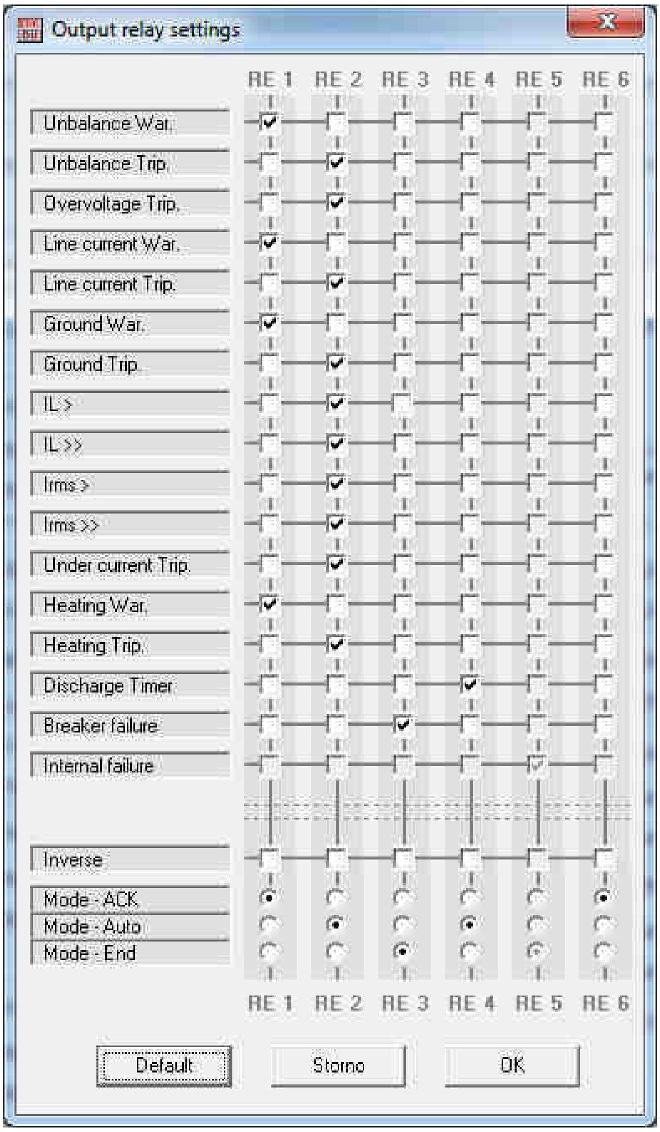
RE2: Mode - Auto;

RE3: Mode - End;

RE4: Mode - Auto;

RE5: for internal failure only;

RE6: Mode - ACK;



12.2 Setting parameter through PC screen

Connection:

- Ports – COM 1 – COM 8 are on the front or rear panel
- Connect - connect or disconnect the connection to relay

- Select Baudrate

Language:

- Select language

Parameter reading:

- From file
- From relay

Parameter writing:

- To file
- To relay

Start compensation: Starting of natural current compensation

Erase compensation: Erase the compensation value

Report: Display of recorded data

Erase report: Erase recorded data

Set date and time: Setting date and time from PC to relay (internal time of the computer is sent to the protection relay)

Measuring: Display of measured data

Info: Service data, program version, communication etc.

Setting relay: Setting network frequency, alarm acknowledgement (automatic, manual) and connection of capacitor bank.

Output relays:

Each relay can be individually set to one of following modes:

- Acknowledgement – output contact is closed until the Acknowledgement button is pressed
- Automatic 1 s – output contact is closed for 1 second
- Automatic – output contact is closed while the condition is met

Optical inputs: Display of optical inputs states

Block or release of protection functions: By clicking the fields Enabled it is possible to enable or disable individual protection functions.

Unbalance protection: Setting parameter of unbalance protection

Lower threshold I_{L1} is the minimum value of current I_{L1}

Lower threshold I_u is the minimum value of current I_u

Overvoltage protection: Setting parameter of Overvoltage protection

IEC(ANSI):

Overvoltage factor

Phase capacitance

Ph/Ph-Voltage (Line to line voltage)

Set time:

Delay

Ph/Ph-Voltage (Line to line voltage)

Capacitor bank discharge timer: Set time

Current transformer ratio: Set the secondary current of current transformers x/1A or x/5 A.

Setting output relays: Setting the output relays, normally energized or de-energized during the power-up healthy condition.

Setting parameters of followed protection:

Line current unbalance protection

Ground current protection

Overcurrent protection

Undercurrent protection

Excessive heating protection: Set time on:

Setting parameters and delay

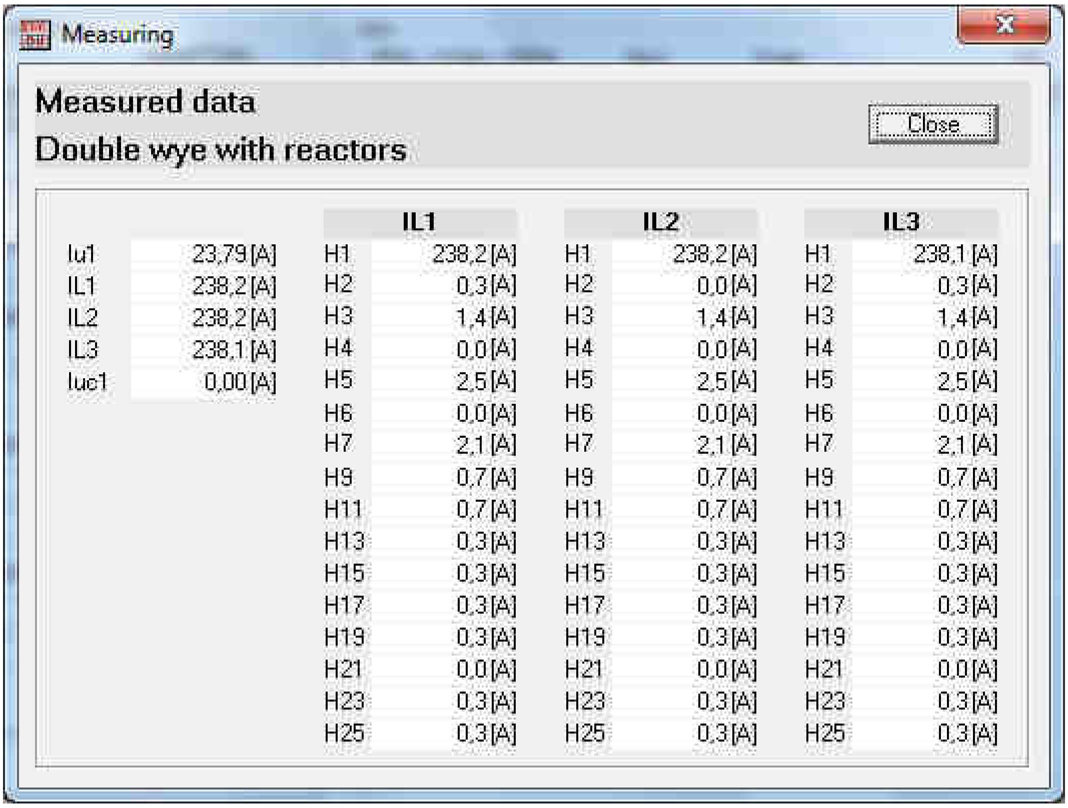
Set time off:

Setting parameters

Delay depend of ratio actual current/ nominal current

Measured data

Measured data on PC screen



Measuring

Measured data

Double wye with reactors

Close

		IL1		IL2		IL3	
Iu1	23,79 [A]	H1	238,2 [A]	H1	238,2 [A]	H1	238,1 [A]
IL1	238,2 [A]	H2	0,3 [A]	H2	0,0 [A]	H2	0,3 [A]
IL2	238,2 [A]	H3	1,4 [A]	H3	1,4 [A]	H3	1,4 [A]
IL3	238,1 [A]	H4	0,0 [A]	H4	0,0 [A]	H4	0,0 [A]
Iuc1	0,00 [A]	H5	2,5 [A]	H5	2,5 [A]	H5	2,5 [A]
		H6	0,0 [A]	H6	0,0 [A]	H6	0,0 [A]
		H7	2,1 [A]	H7	2,1 [A]	H7	2,1 [A]
		H9	0,7 [A]	H9	0,7 [A]	H9	0,7 [A]
		H11	0,7 [A]	H11	0,7 [A]	H11	0,7 [A]
		H13	0,3 [A]	H13	0,3 [A]	H13	0,3 [A]
		H15	0,3 [A]	H15	0,3 [A]	H15	0,3 [A]
		H17	0,3 [A]	H17	0,3 [A]	H17	0,3 [A]
		H19	0,3 [A]	H19	0,3 [A]	H19	0,3 [A]
		H21	0,0 [A]	H21	0,0 [A]	H21	0,0 [A]
		H23	0,3 [A]	H23	0,3 [A]	H23	0,3 [A]
		H25	0,3 [A]	H25	0,3 [A]	H25	0,3 [A]

Measuring

Measured data

Double wye without reactors

Close

		IL1		IL2		IL3	
Iu1	23,79 [A]	H1	238,2 [A]	H1	238,2 [A]	H1	238,1 [A]
IL1	238,2 [A]	H2	0,0 [A]	H2	0,0 [A]	H2	0,0 [A]
IL2	238,2 [A]	H3	1,4 [A]	H3	1,4 [A]	H3	1,4 [A]
IL3	238,1 [A]	H4	0,0 [A]	H4	0,0 [A]	H4	0,0 [A]
Iuc1	23,80 [A]	H5	2,5 [A]	H5	2,5 [A]	H5	2,5 [A]
		H6	0,0 [A]	H6	0,0 [A]	H6	0,0 [A]
		H7	2,1 [A]	H7	2,1 [A]	H7	1,8 [A]
		H9	0,7 [A]	H9	0,7 [A]	H9	0,7 [A]
		H11	0,7 [A]	H11	0,7 [A]	H11	0,7 [A]
		H13	0,3 [A]	H13	0,3 [A]	H13	0,3 [A]
		H15	0,3 [A]	H15	0,3 [A]	H15	0,3 [A]
		H17	0,3 [A]	H17	0,3 [A]	H17	0,3 [A]
		H19	0,7 [A]	H19	0,7 [A]	H19	0,7 [A]
		H21	0,0 [A]	H21	0,0 [A]	H21	0,0 [A]
		H23	0,0 [A]	H23	0,0 [A]	H23	0,3 [A]
		H25	0,3 [A]	H25	0,3 [A]	H25	0,3 [A]

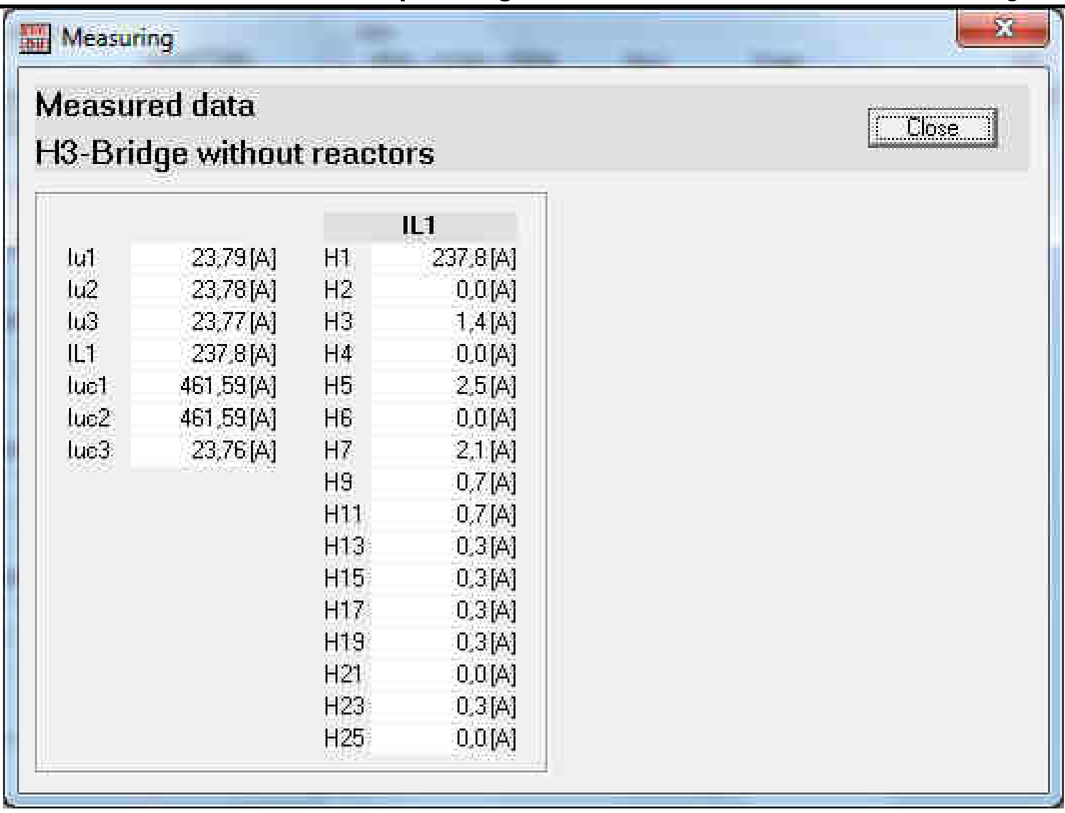
Measuring

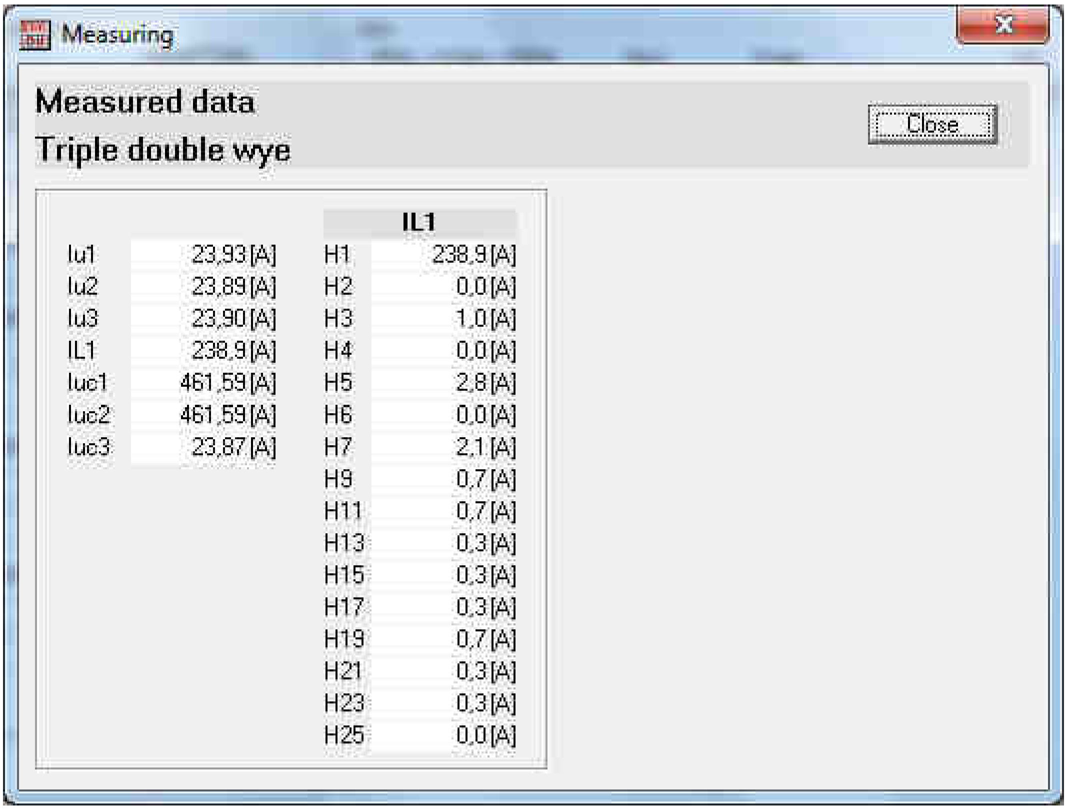
Measured data

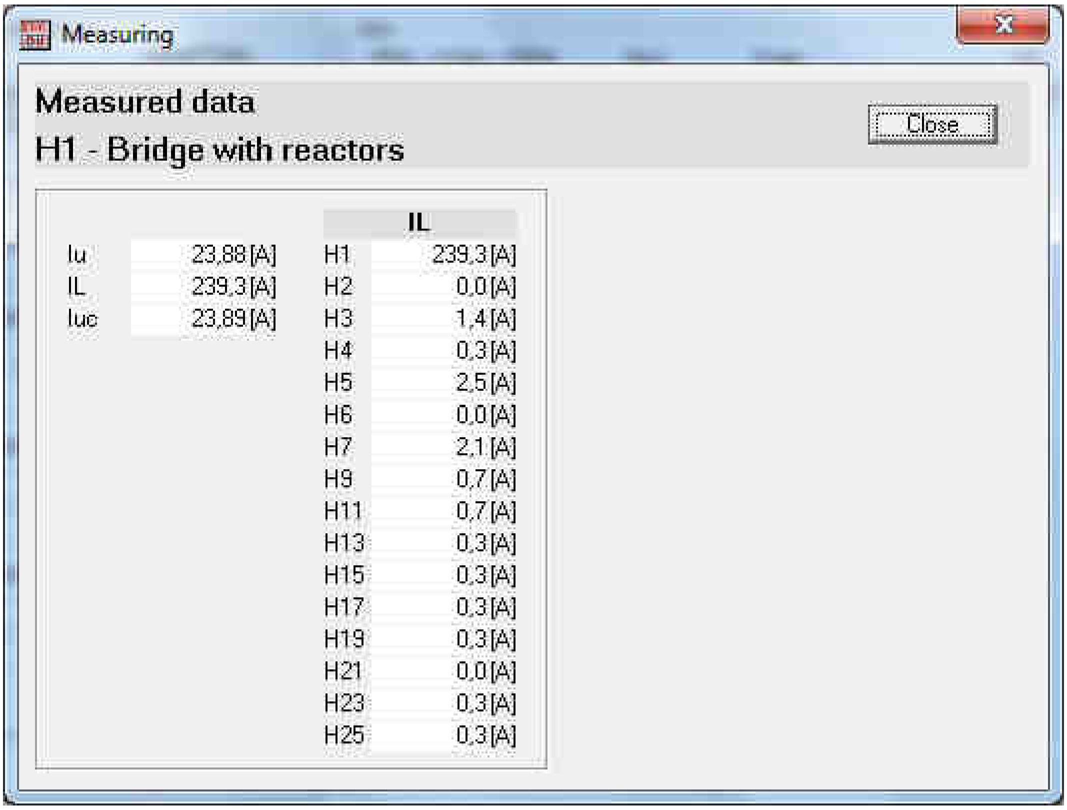
H3 - Bridge with reactors

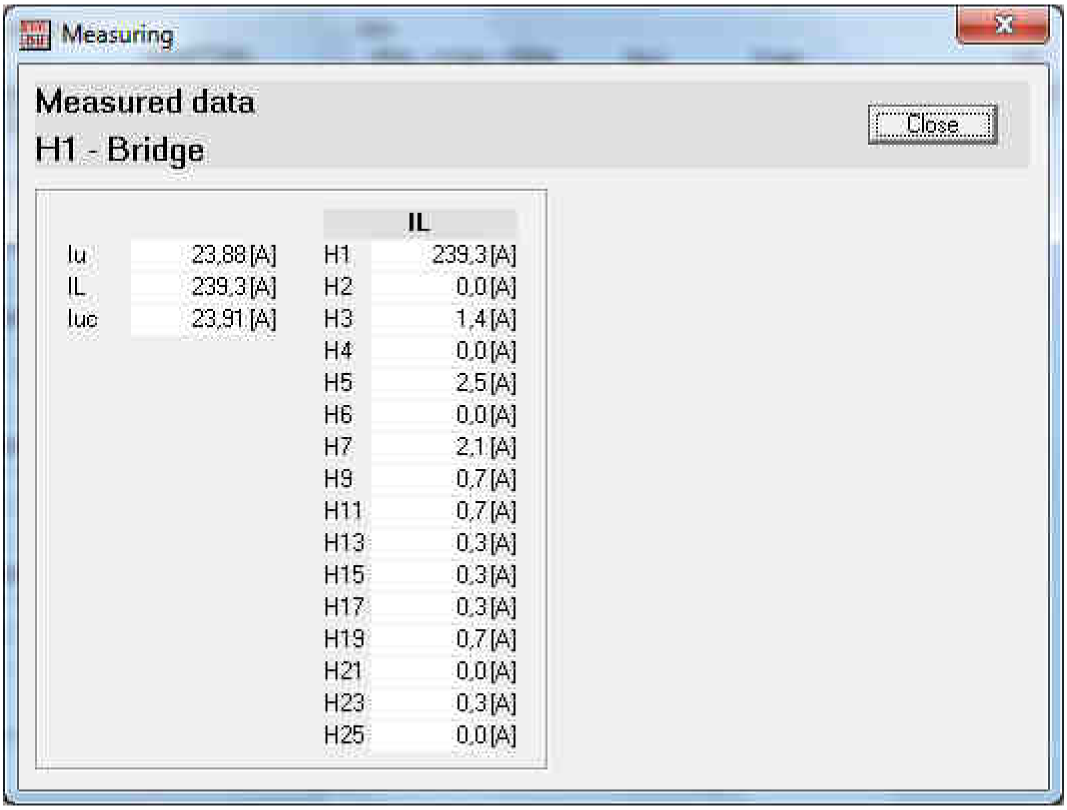
Close

		IL1	
Iu1	23,90 [A]	H1	238,9 [A]
Iu2	23,85 [A]	H2	0,0 [A]
Iu3	23,86 [A]	H3	1,4 [A]
IL1	238,9 [A]	H4	0,0 [A]
Iuc1	461,59 [A]	H5	2,5 [A]
Iuc2	461,59 [A]	H6	0,0 [A]
Iuc3	23,85 [A]	H7	2,1 [A]
		H9	0,7 [A]
		H11	0,7 [A]
		H13	0,3 [A]
		H15	0,3 [A]
		H17	0,3 [A]
		H19	0,3 [A]
		H21	0,0 [A]
		H23	0,0 [A]
		H25	0,0 [A]


Measuring
Measured data
H3-Bridge without reactors
Close
IL1
Iu1 23,79 [A]
Iu2 23,78 [A]
Iu3 23,77 [A]
IL1 237,8 [A]
Iuc1 461,59 [A]
Iuc2 461,59 [A]
Iuc3 23,76 [A]
H1 237,8 [A]
H2 0,0 [A]
H3 1,4 [A]
H4 0,0 [A]
H5 2,5 [A]
H6 0,0 [A]
H7 2,1 [A]
H9 0,7 [A]
H11 0,7 [A]
H13 0,3 [A]
H15 0,3 [A]
H17 0,3 [A]
H19 0,3 [A]
H21 0,0 [A]
H23 0,3 [A]
H25 0,0 [A]

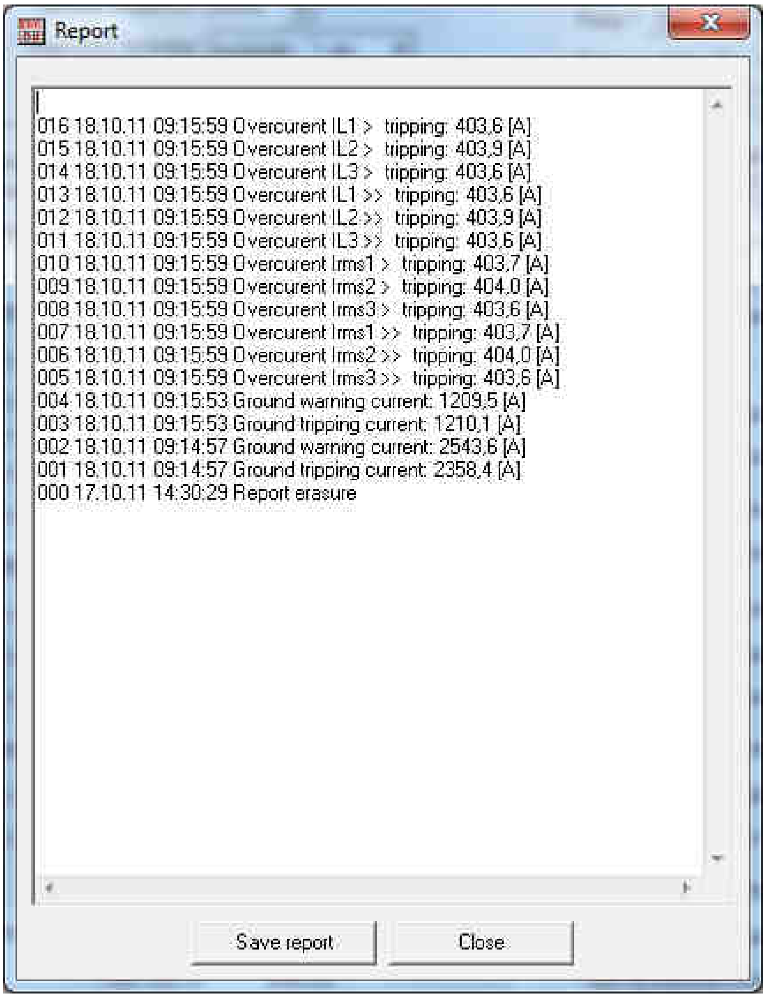

Measuring
Measured data
Triple double wye
Close
IL1
Iu1 23,93 [A]
Iu2 23,89 [A]
Iu3 23,90 [A]
IL1 238,9 [A]
Iuc1 461,59 [A]
Iuc2 461,59 [A]
Iuc3 23,87 [A]
H1 238,9 [A]
H2 0,0 [A]
H3 1,0 [A]
H4 0,0 [A]
H5 2,8 [A]
H6 0,0 [A]
H7 2,1 [A]
H9 0,7 [A]
H11 0,7 [A]
H13 0,3 [A]
H15 0,3 [A]
H17 0,3 [A]
H19 0,7 [A]
H21 0,3 [A]
H23 0,3 [A]
H25 0,0 [A]


Measuring
Measured data
H1 - Bridge with reactors
Close
Iu 23,88 [A]
IL 239,3 [A]
Iuc 23,89 [A]
IL
H1 239,3 [A]
H2 0,0 [A]
H3 1,4 [A]
H4 0,3 [A]
H5 2,5 [A]
H6 0,0 [A]
H7 2,1 [A]
H9 0,7 [A]
H11 0,7 [A]
H13 0,3 [A]
H15 0,3 [A]
H17 0,3 [A]
H19 0,3 [A]
H21 0,0 [A]
H23 0,3 [A]
H25 0,3 [A]


Measuring
Measured data
H1 - Bridge
Close
Iu 23,88 [A]
IL 239,3 [A]
Iuc 23,91 [A]
IL
H1 239,3 [A]
H2 0,0 [A]
H3 1,4 [A]
H4 0,0 [A]
H5 2,5 [A]
H6 0,0 [A]
H7 2,1 [A]
H9 0,7 [A]
H11 0,7 [A]
H13 0,3 [A]
H15 0,3 [A]
H17 0,3 [A]
H19 0,7 [A]
H21 0,0 [A]
H23 0,3 [A]
H25 0,0 [A]

Report

Example of Report



On LCD display is possible to display only data of the last event.

<u>Measured data on LCD display:</u>

I_{u1}; I_{u2}; I_{u3}

$I_{L1;}$ $I_{L2;}$ I_{L3}

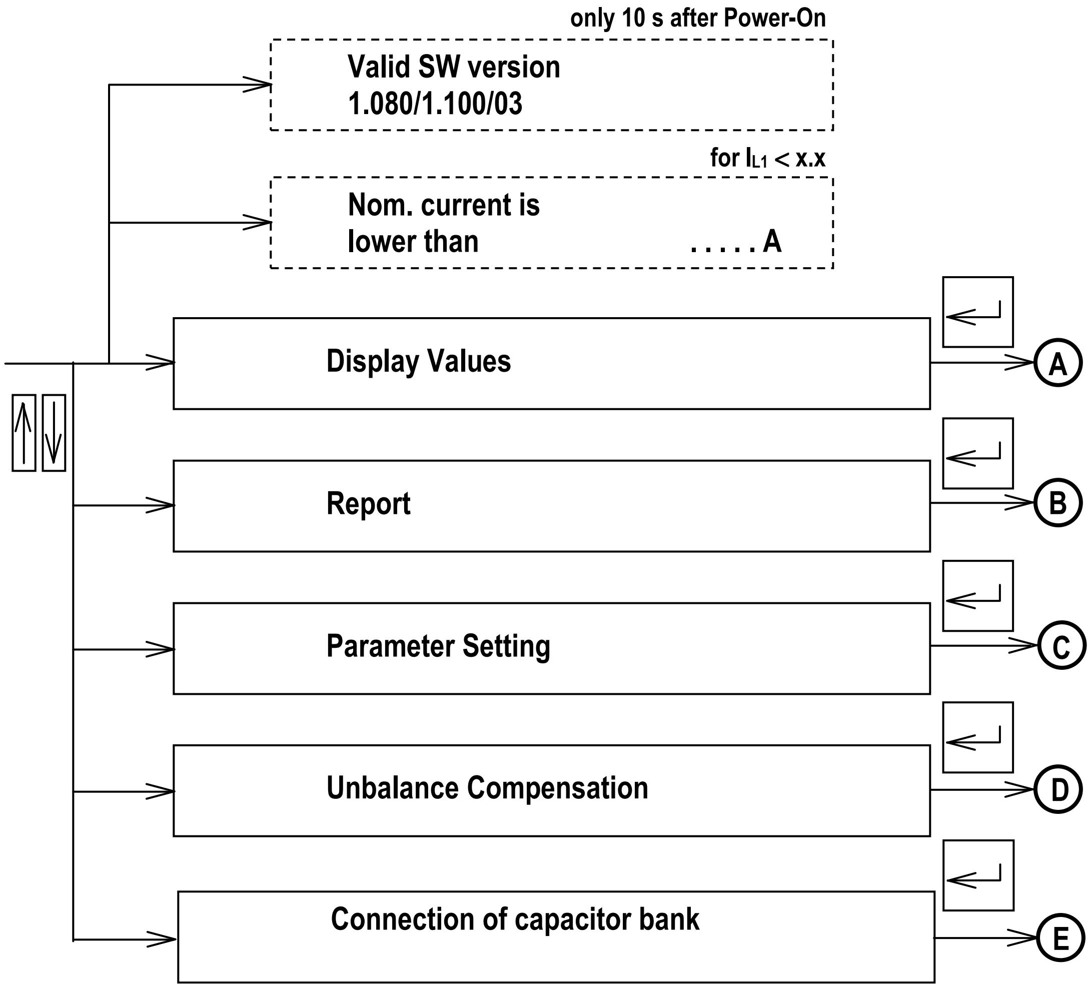
The data are displayed in dependence on connection of capacitor bank.

Legend:

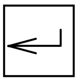
I_{u1};I_{u2};I_{u3}	Unbalance currents
$I_{L1;}$ $I_{L2;}$ I_{L3}	Line currents

13 Display menu

MAIN MENU



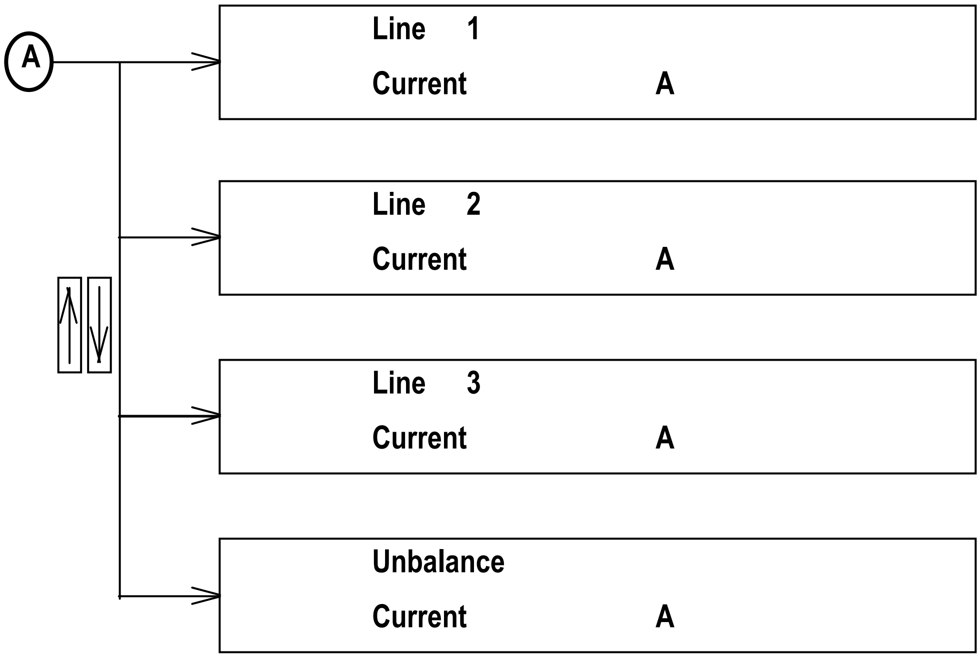
Legend :



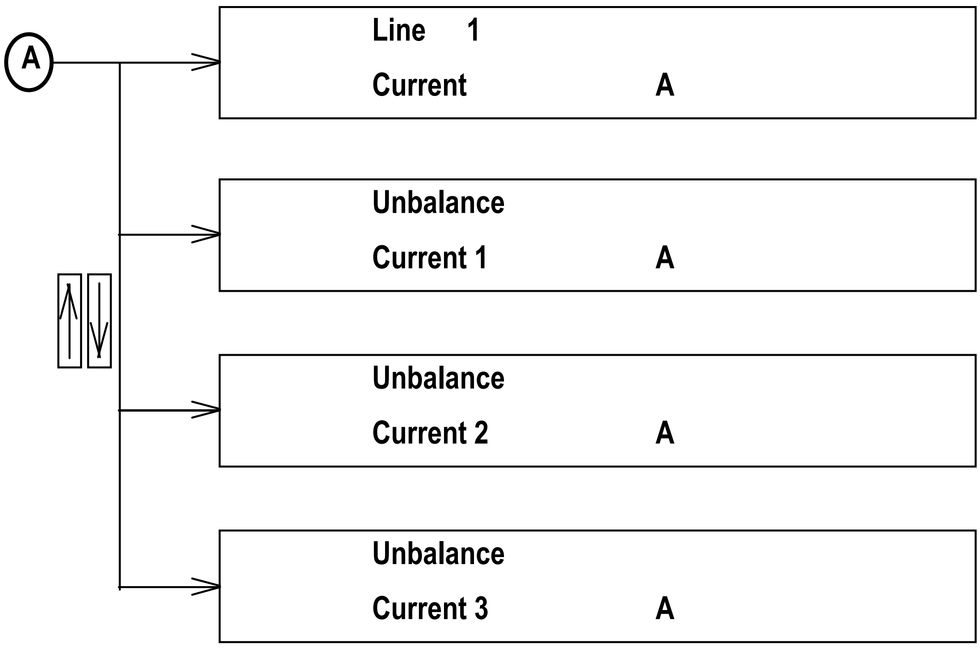
ENTER

DISPLAY VALUES

DOUBLE WYE (WITH REACTORS)

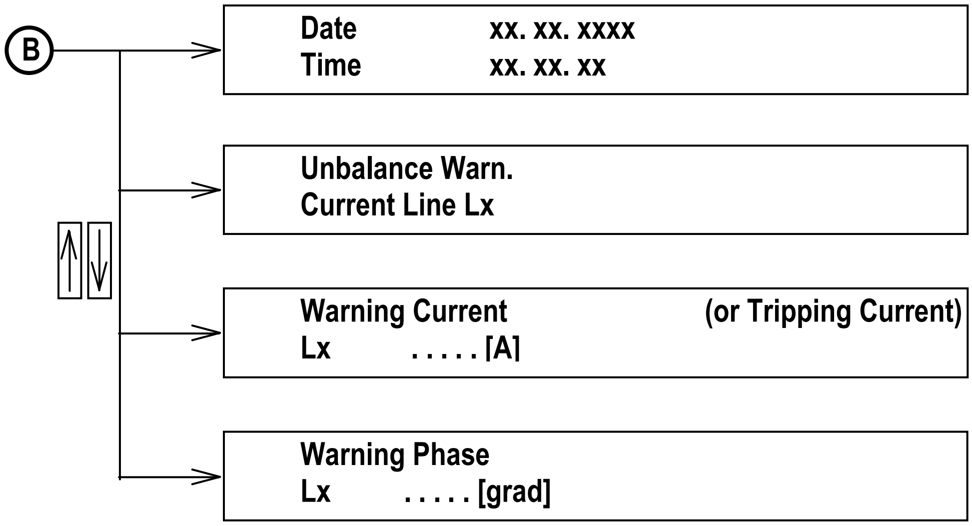


H – BRIDGE (WITH REACTORS), TRIPLE DOUBLE WYE



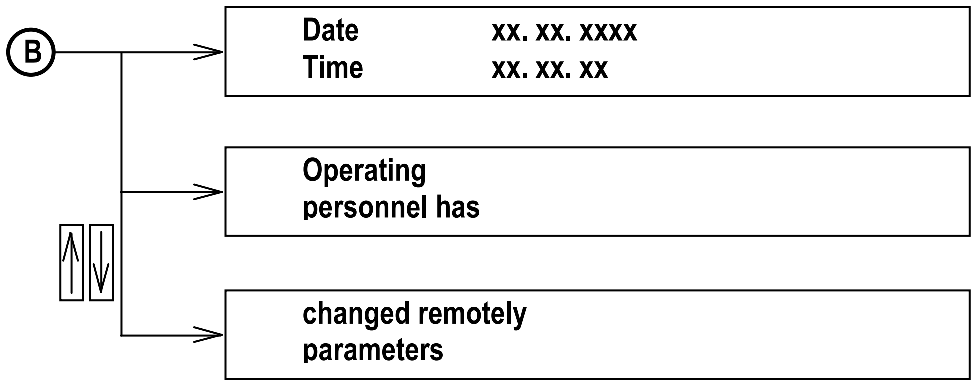
REPORT

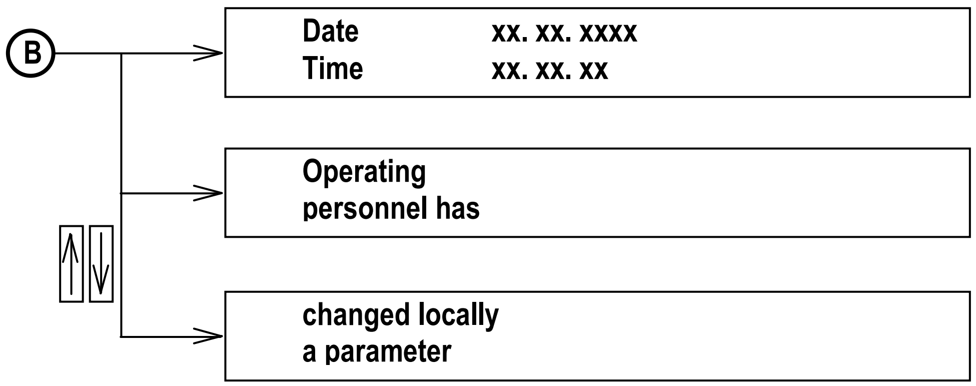
(only for Unbalance Protection)



<u>TABLE EVENT</u>:

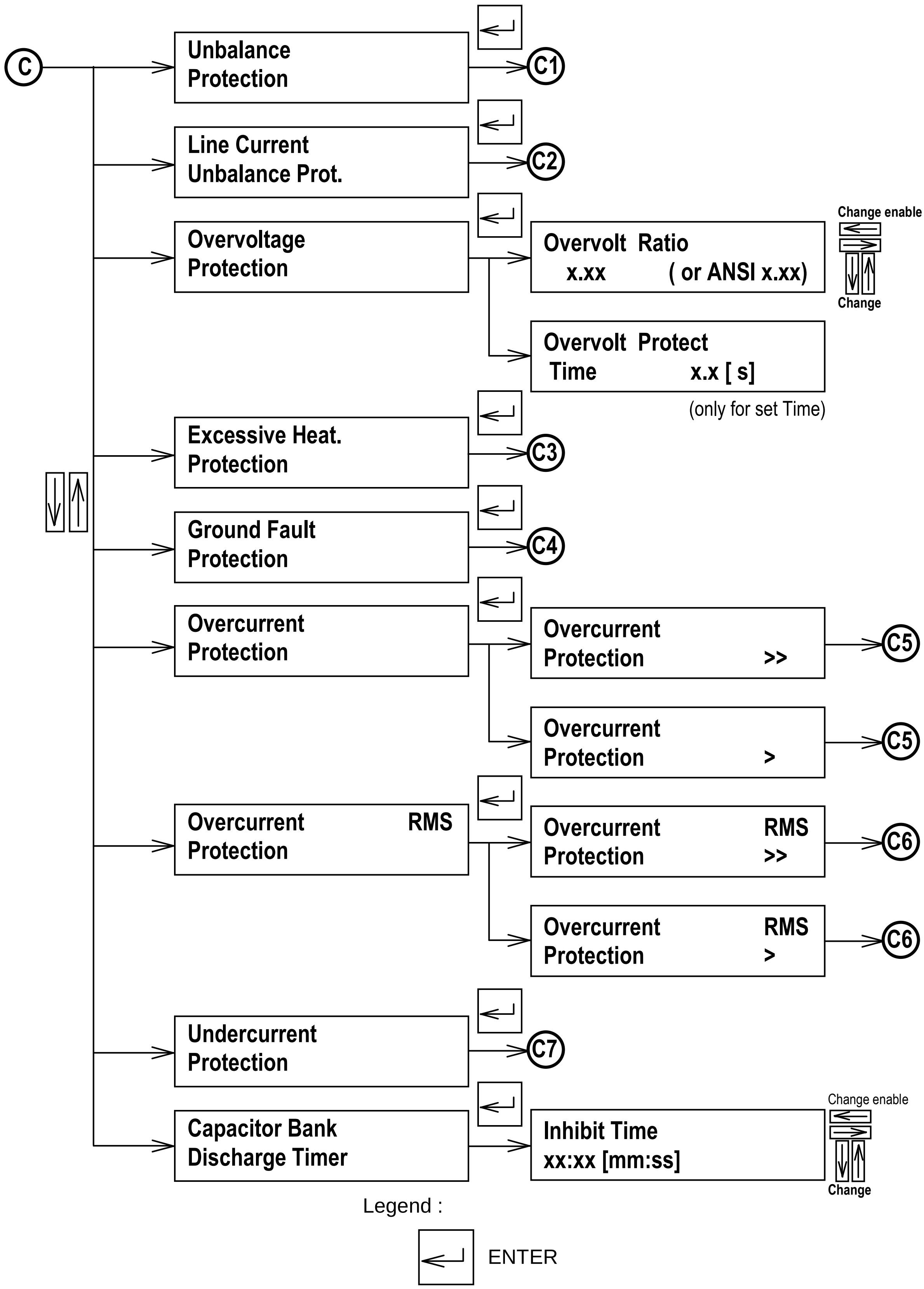
- Line Curr. L1 – L2 (or L1 – L3; L2 – L3)
  Unbalance Warn. (or Trip.)
- Capacitor Over
  Voltage L1 Trip. (or L1; L2)
- Excessive L1 (or L2; L3)
  Heating Warn. (or Trip.)
- Ground Fault
  Warn. (or Trip.)
- Overcurrent L1 (or L2; L3)
  Trip.
  Undercurrent L1 (or L2; L3)
  Trip.
- Capacitor Bank
  Discharge Time


B
Date xx. xx. xxxx
Time xx. xx. xx
Operating
personnel has
changed remotely
parameters


B
Date xx. xx. xxxx
Time xx. xx. xx
Operating
personnel has
changed locally
a parameter

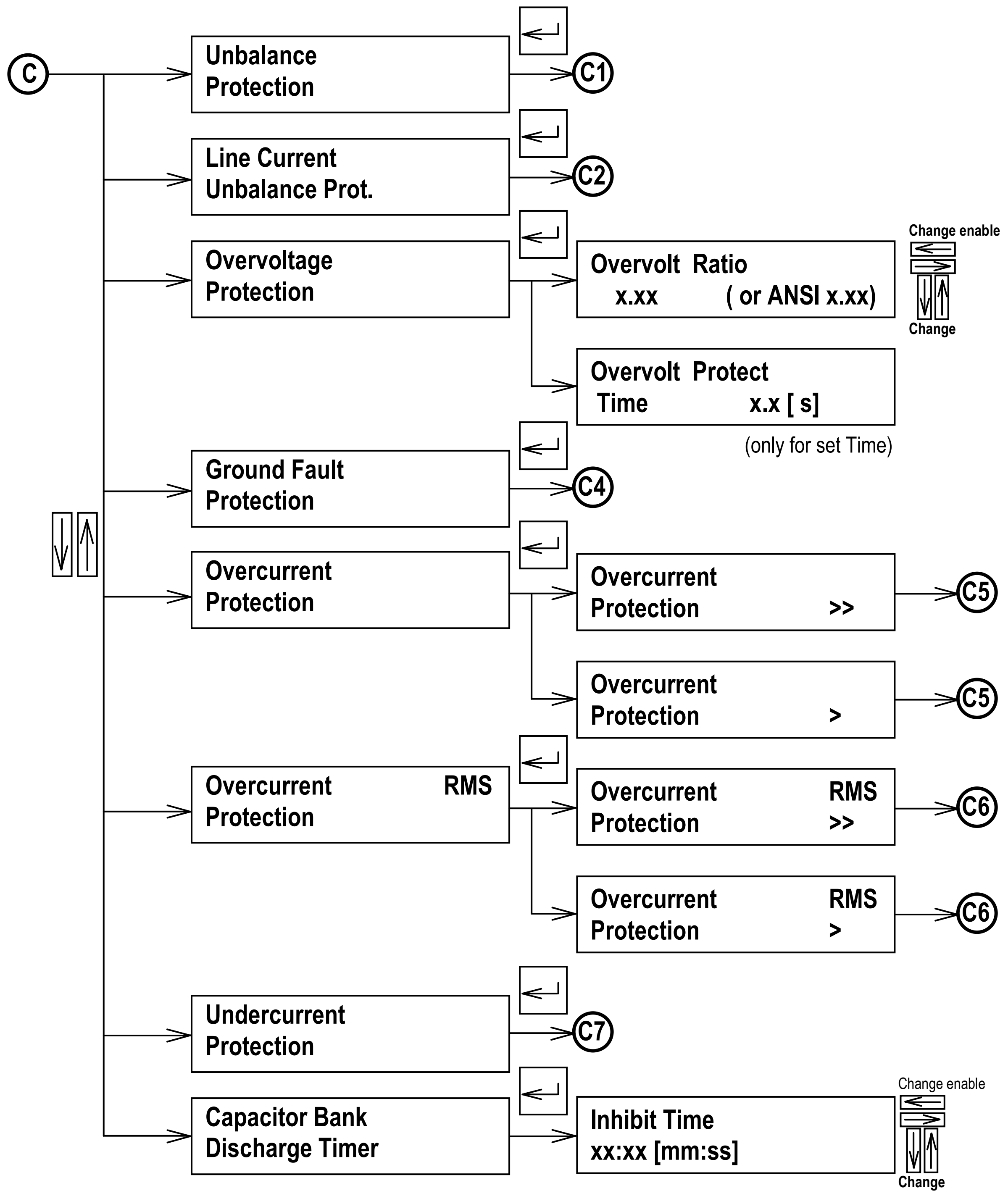
PARAMETER SETTING

DOUBLE WYE WITH REACTORS



PARAMETER SETTING

DOUBLE WYE WITHOUT REACTORS

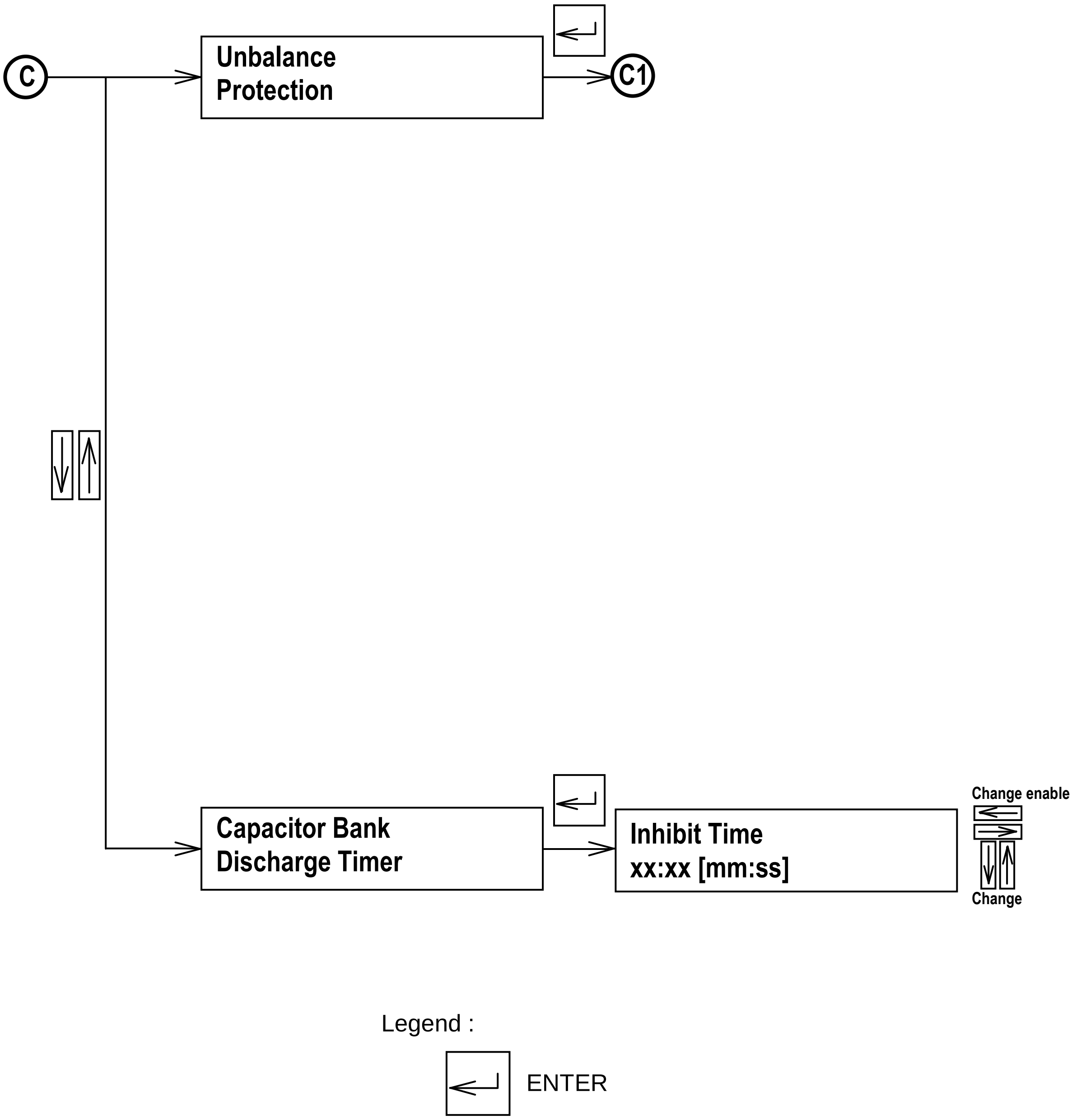


Legend :

ENTER

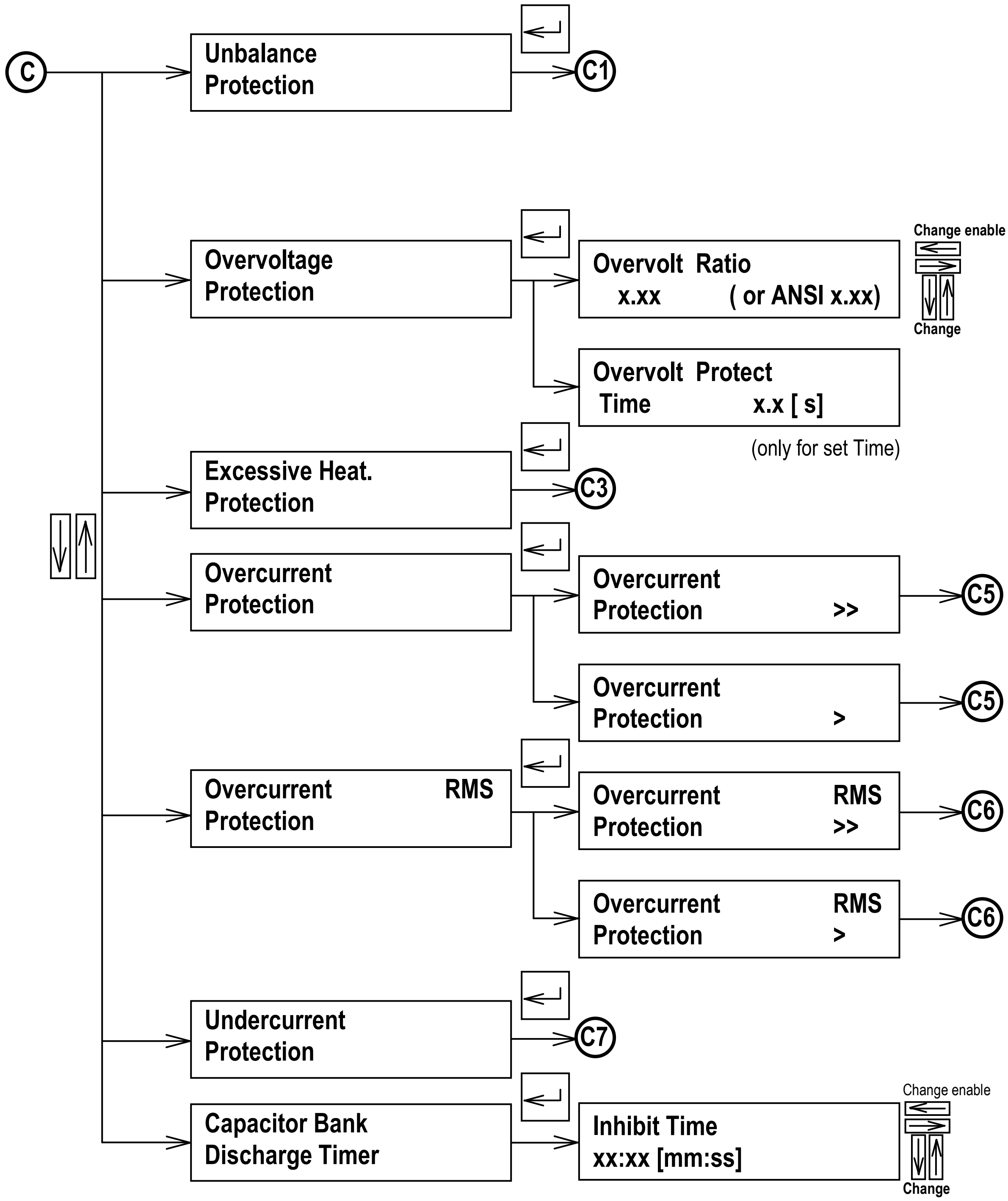
PARAMETER SETTING

H- BRIDGE H1 WITH OR WITHOUT REACTORS



PARAMETER SETTING

H- BRIDGE H1 WITH REACTORS

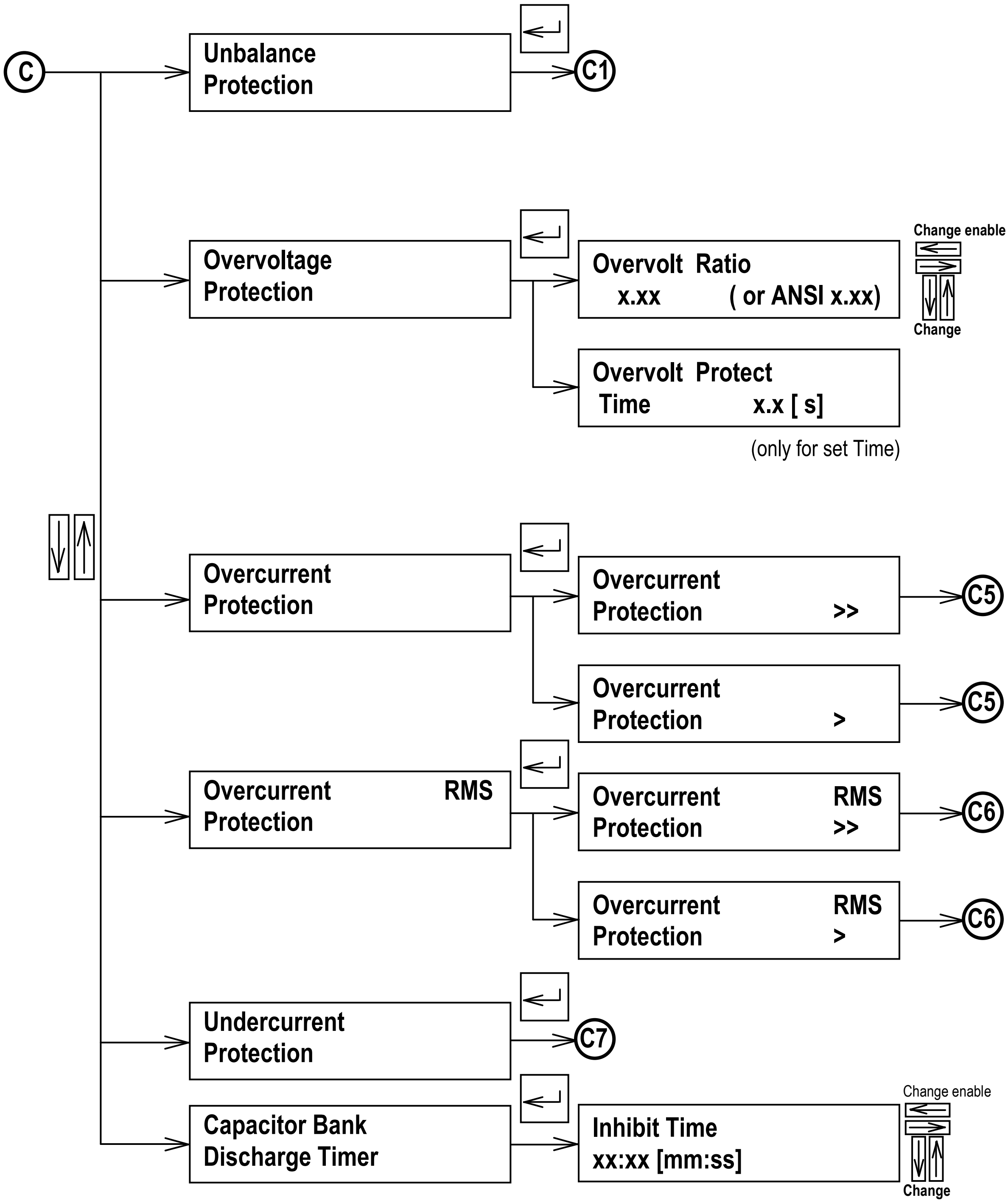


Legend :

ENTER

PARAMETER SETTING

H - BRIDGE H1 WITHOUT REACTORS

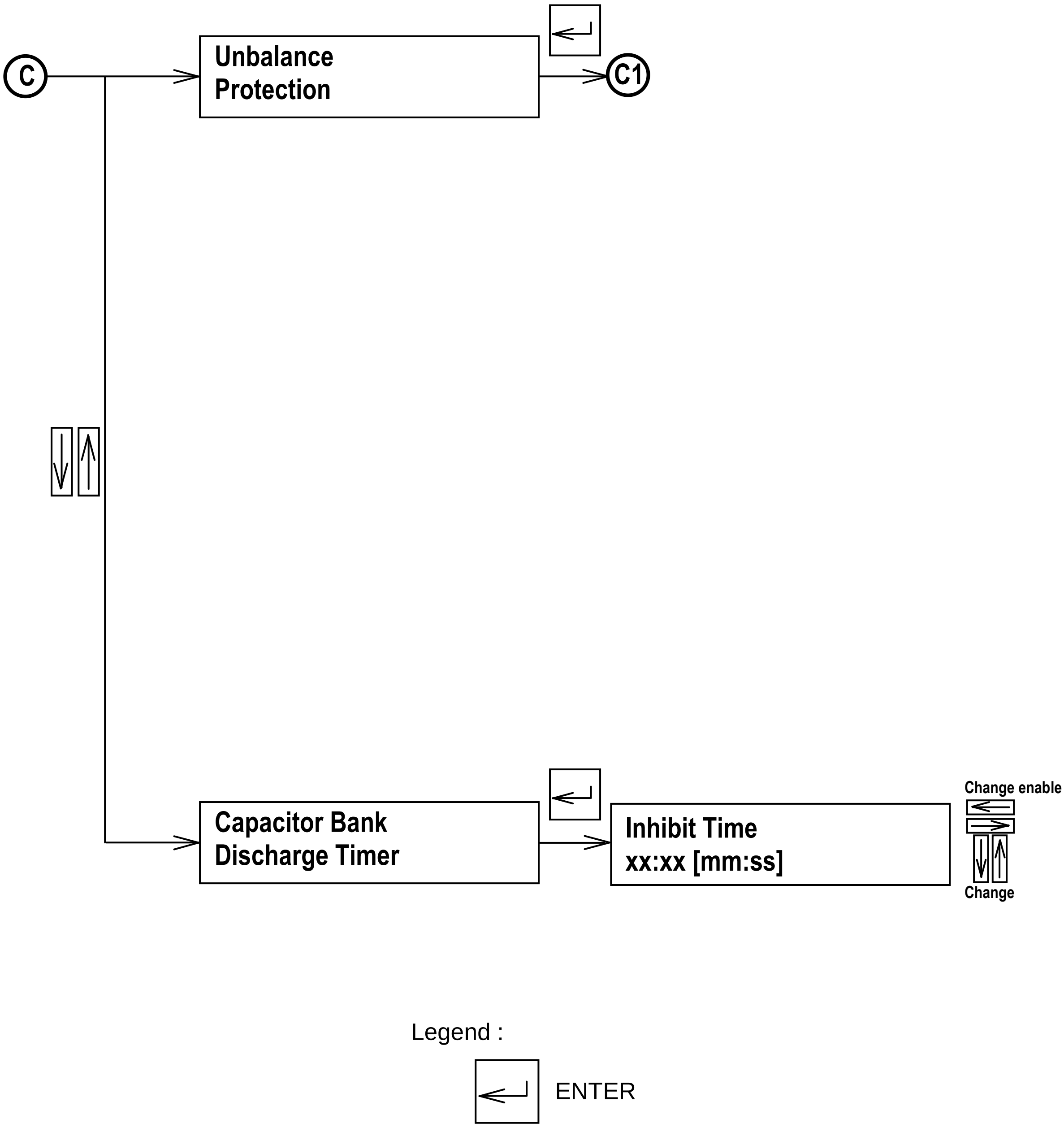


Legend :

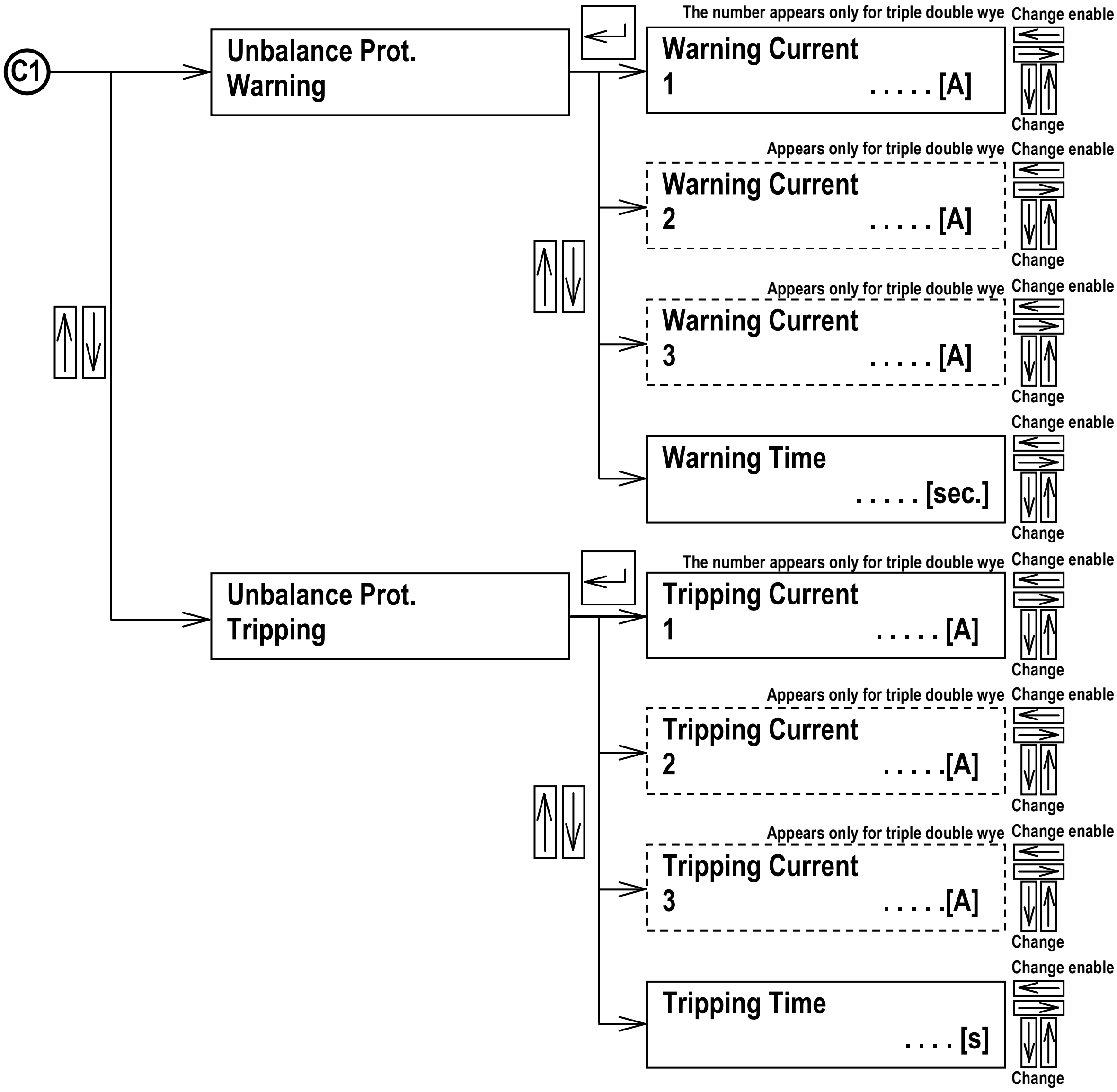
ENTER

PARAMETER SETTING

TRIPLE DOUBLE WYE



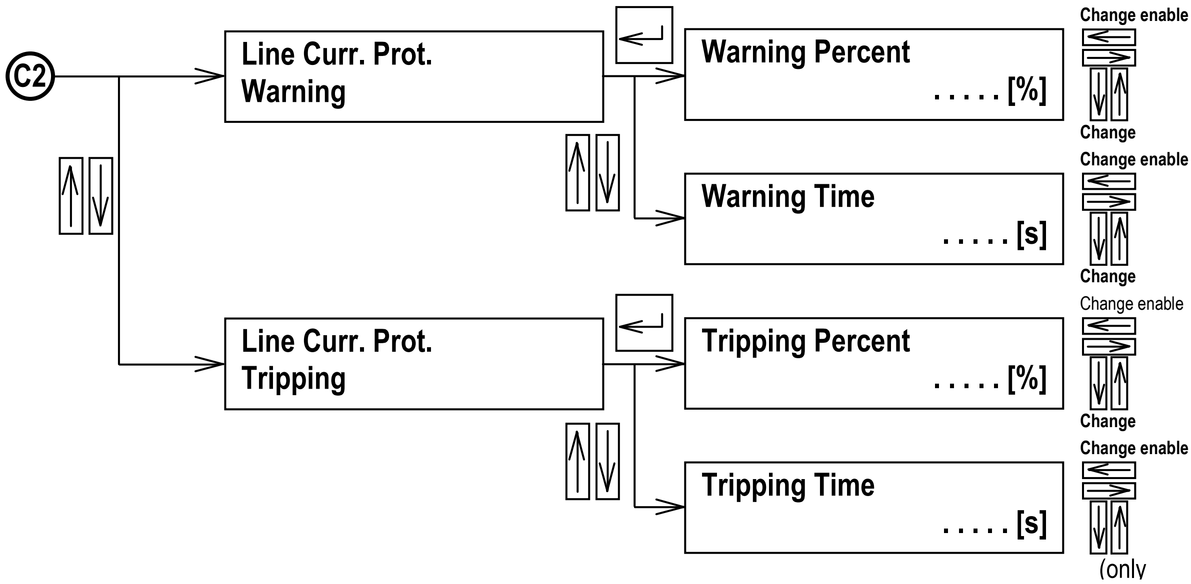
PARAMETER SETTING

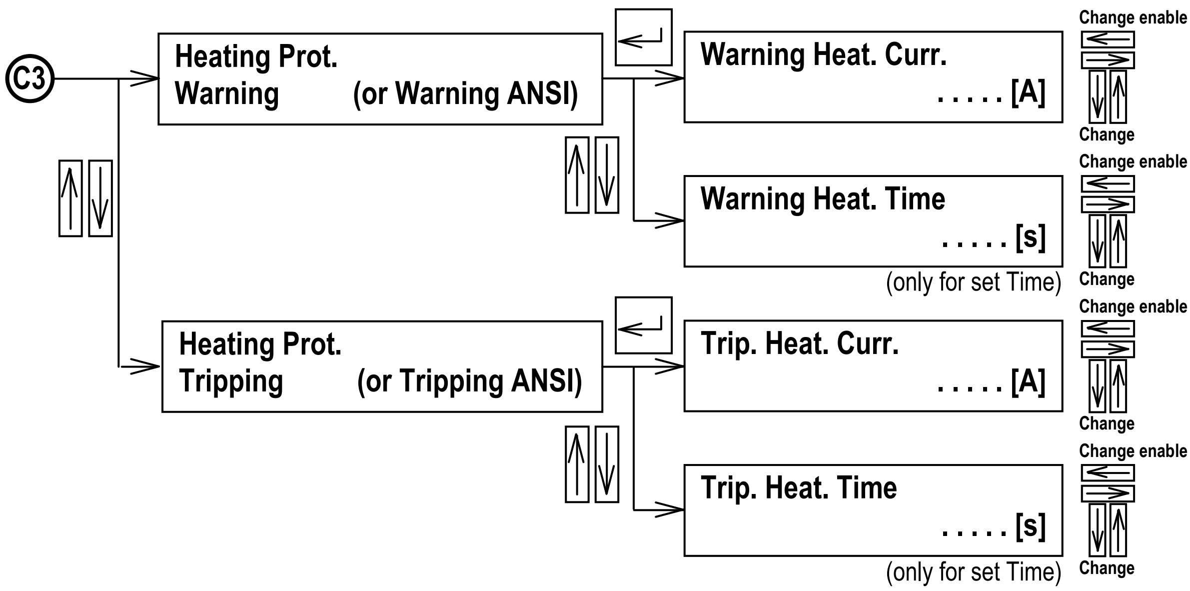


Legend :

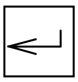
ENTER

PARAMETER SETTING

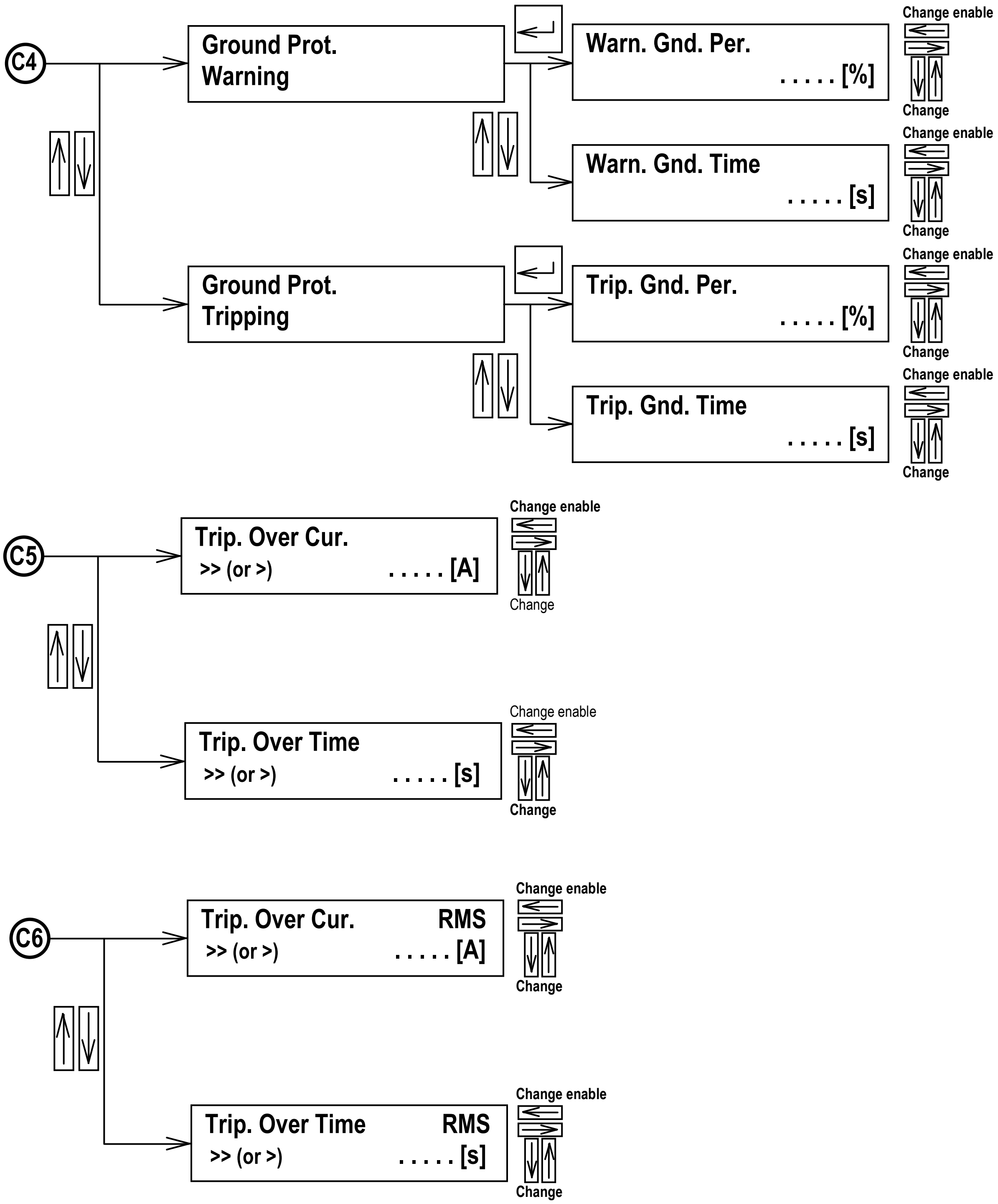




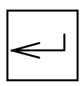
Legend :


ENTER

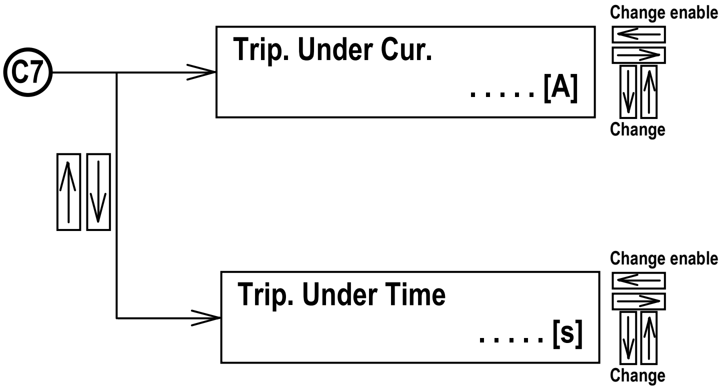
Parameter setting



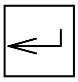
Legend :



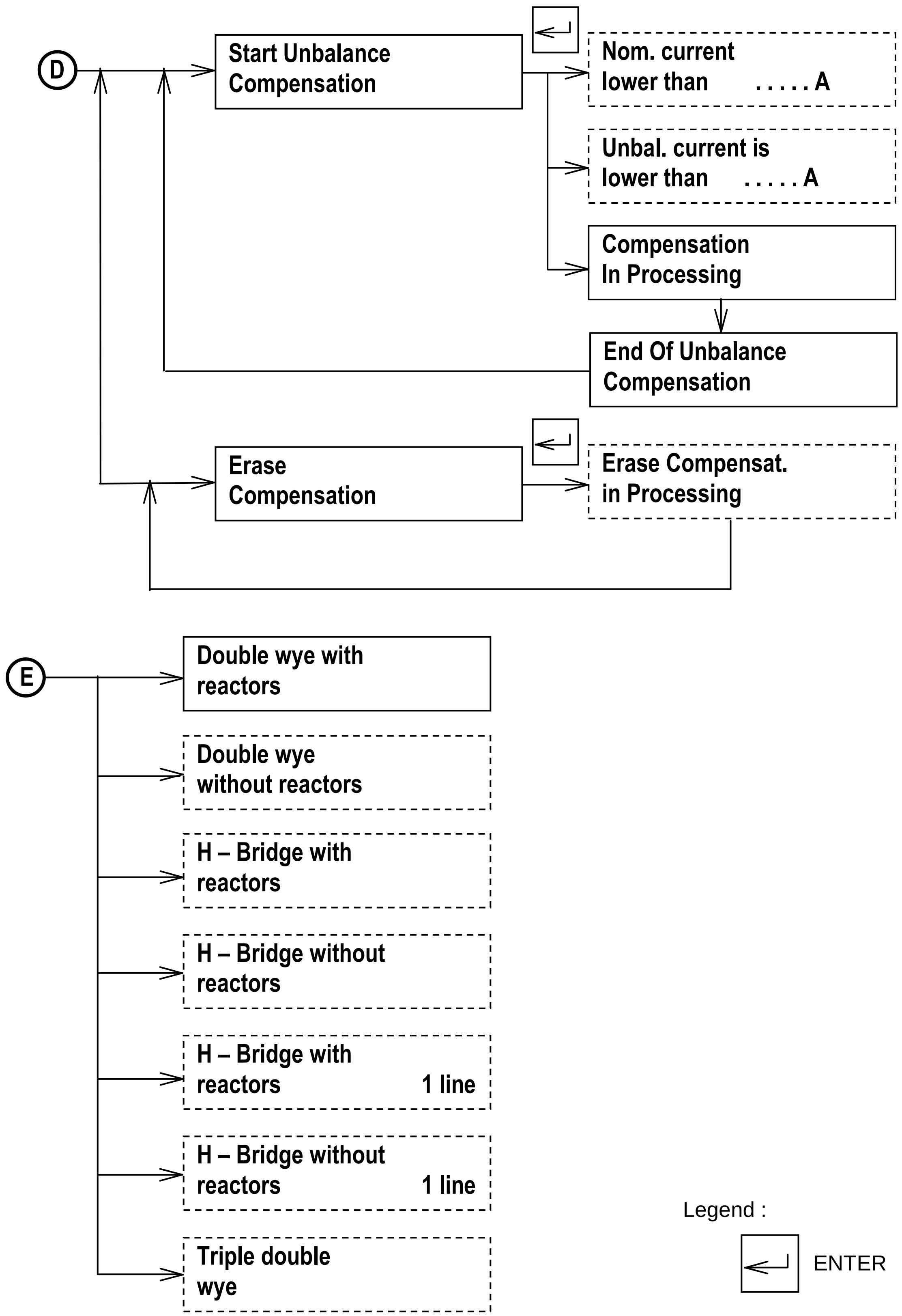
ENTER



Legend :


ENTER

UNBALANCE COMPENSATION



14 Technical data

Current inputs	
Rated current	Four current inputs, each can be parameterized to 1A or 5A. Maximum current transformer ratio is 6000/x
Thermal current withstand	
- Continuously	15A
- For 1 second	100A
Optron inputs	20 – 220 V DC
Rated frequency	50Hz / 60Hz
Power supply	
Standard	100-375 V DC or 100-240 AC 50/60Hz
Option	18-75V DC
Power consumption	10 VA
Output contact rating	
Continuous carry	8A / 265 V AC 0,3A / 300V DC 8A / 30V DC
Data transmission	Interface RS 232 on the front panel or RS 485 and RS 232 on the rear panel. Baudrate is selectable by the PC software. RS 485 is not used by the software now.
Metering of harmonics:	Odd harmonics up to 25-th, even up to 6-th
Environmental conditions:	
Operating temperature	- 10 up to + 60°C
Storage temperature	- 20 up to + 70° C
Dimensions	135 x 135 x 121 mm (w x h x d)
Degree of protection of the relay	IP 54

15 Immunity tests

Conducted rf disturbance test according to: EN 61000-6-4, industrial environment and EN 550 11/A.

Level:	Allowed value:
30 – 230 MHz	40dB (µV/m)
230 – 1000 MHz	47 dB (µV/m), l = 10 m.
0,15 – 0,5 MHz	79 dB(µV/m)/66 dB(µV/m)
0,5 – 30 MHz,	73 dB(µV/m)/60 dB(µV/m)

Interference voltages introduced into the mains according to: EN 55011/A
0, 15 – 30 MHz, step 8 kHz, measurement time 1 s

Interfering radiation in the 30 – 1000 MHz band 38,9 – 50,9 dB (µV/m)

Test of electric discharge resistance according to: EN 61000-4-2 (IEC 801-2), IEC 1000-4-2, ČSN EN 610000-4-2. Temperature: 22 ˚C, rel. humidity: 51%

Testing voltage:	4 kV contact
	8 kV air

Immunity test radiated electromagnetic field requirements according to: EN 61000-4-3, IEC 1000-4-3 (IEC 801-3)
Operating conditions: scan spectrum: 80 to 1000 MHz, mod. 80% AM/1 kHz, intensity of field: 10V/m

Test by quick transient burst according to: EN 61 000-4-4, IEC 100-4-4 (IEC 801-4).
Testing voltage applied:
By link circuit into supply, testing voltage: ± 2 kV
By capacity clamp into supply, testing voltage ±1 kV
By capacity clamp into in/out cable, testing voltage ± 1 kV

Surge immunity test according to: EN 61000-4-5, IEC 1000-4-5, IEC 801-5.
Testing voltage applied:
Line to line ± 1 kV
Line to ground ± 2 kV
To in/out ± 1 kV

Immunity test – conducted disturbances inducted by radio – frequency fields, according to: EN 61000- 4-6, IEC 61000-4-6, EN 61000-4-6.
Test level 10V, scan spectrum 150 kHz – 80 MHz, mod 80% AM/1 kHz

Voltage dips, short interruption and voltage variations, according to EN 61000-4-11:1996

Test level	70%U_t, duration 10 ms
Test level	40%$U_{t,}$ duration 100ms
Test level	40%U_t duration 1000 ms

16 Dimensions and cut-out details

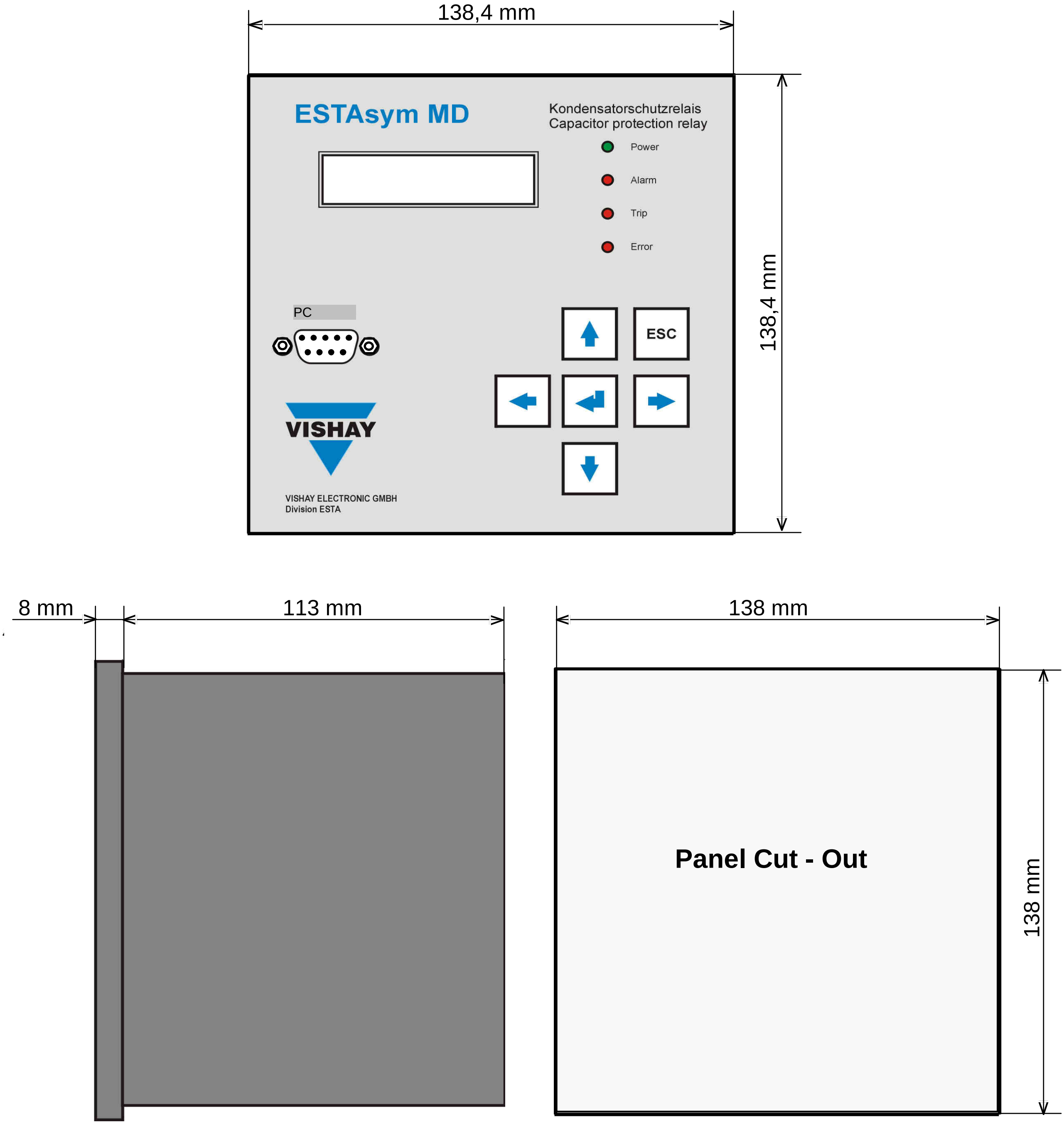


Fig. 4 Dimensions and cut-out details

17 Times of warning and tripping for the overheating protection

I_{set}/I_n	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
Warning[s]	4041	2700	1853	1302	935	683	508	383	293	227	177	140	112
Tripping [s]	8082	5400	3706	2604	1869	1366	1015	765	585	453	354	280	223
I_{set}/I_n	2,6	2,7	2,8	2,9	3	3,1	3,2	3,3	3,4	3,5	3,6	3,7	3,8
Warning [s]	90	73	60	49	41	34	29	24	21	18	15	13	11
Tripping [s]	180	146	119	98	81	68	57	48	41	35	30	25	22
I_{set}/I_n	3,9	4	4,1	4,2	4,3	4,4	4,5	4,6	4,7	4,8	4,9	>= 5	
Warning [s]	10	8	7	7	6	5	5	4	4	3	3	0	
Tripping [s]	19	16	14	13	11	10	9	8	7	6	5	0	

18 Times of tripping for Overvoltage protection

Factor 0,80

Uc/Ucr	0,84	0,85	0,86	0,87	0,88	0,89	0,90	0,92	0,94	0,96
Time [s]	1000	850	700	550	400	250	100	84	68	52

Uc/Ucr	0,98	1,00	1,02	1,04	1,06	1,08	1,10	1,14	1,17	1,20
Time [s]	36	20	16,8	13,6	10,4	7,2	4,0	2,9	2,0	1,2

Uc/Ucr	1,30	1,40	1,50	1,60	1,70	1,80	1,90	2,00	2,10	2,20
Time [s]	0,6	0,4	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1

Factor 0,90

Uc/Ucr	0,95	0,96	0,97	0,98	0,99	1,00	1,02	1,04	1,06	1,08
Time [s]	1000	828,8	657,6	486,4	315,2	144	121,2	98,4	75,6	52,8

Uc/Ucr	1,10	1,12	1,14	1,16	1,18	1,20	1,23	1,26	1,30	1,40
Time [s]	30	25,2	20,4	15,6	10,8	6,0	4,8	3,6	2,0	0,9

Uc/Ucr	1,50	1,60	1,70	1,80	1,90	2,00	2,10	2,20	2,30	2,40
Time [s]	0,5	0,3	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1

Factor 1,00

Uc/Ucr	1,06	1,07	1,08	1,09	1,10	1,12	1,14	1,16	1,18	1,20
Time [s]	1000	800	600	400	200	170	140	110	80	50

Uc/Ucr	1,22	1,24	1,26	1,28	1,30	1,32	1,35	1,38	1,40	1,50
Time [s]	42	34	26	18	10	8,6	6,5	4,4	3,0	1,4

Uc/Ucr	1,60	1,70	1,80	1,90	2,00	2,10	2,20	2,30	2,40	2,50
Time[s]	0,8	0,5	0,3	0,2	0,1	0,1	0,1	0,1	0,1	0,1

Factor 1,10

Uc/Ucr	1,16	1,17	1,18	1,19	1,20	1,22	1,24	1,26	1,28	1,30
Time [s]	1000	825	650	475	300	252	204	156	108	60

Uc/Ucr	1,32	1,34	1,36	1,38	1,40	1,42	1,45	1,48	1,50	1,60
Time [s]	51	42	33	24	15	13	10	7	5	2

Uc/Ucr	1,70	1,80	1,90	2,00	2,10	2,20	2,30	2,40	2,50	2,60
Time [s]	1,0	0,6	0,4	0,3	0,2	0,1	0,1	0,1	0,1	0,1

Factor 1,25

Uc/Ucr	1,32	1,33	1,34	1,35	1,36	1,37	1,38	1,39	1,40	1,42
Time[s]	1000	890	780	670	560	450	340	230	120	105

Uc/Ucr	1,44	1,46	1,48	1,50	1,52	1,54	1,56	1,58	1,60	1,63
Time [s]	90	75	60	45	38,4	31,8	25,2	18,6	12	9,7

Uc/Ucr	1,66	1,70	1,80	1,90	2,00	2,10	2,20	2,30	2,40	2,50
Time [s]	7,4	4,4	2,0	1,1	0,7	0,5	0,4	0,3	0,2	0,1

Factor 1,50

Uc/Ucr	1,59	1,60	1,61	1,62	1,63	1,64	1,65	1,66	1,67	1,68
Time [s]	1000	700	640	580	520	460	400	340	280	220

Uc/Ucr	1,69	1,70	1,72	1,74	1,76	1,78	1,80	1,83	1,86	1,90
Time [s]	160	100	88,8	77,6	66,4	55,2	44	35,3	26,6	15

Uc/Ucr	2,00	2,10	2,20	2,30	2,40	2,50	2,60	2,70	2,80	2,90
Time [s]	6	3	1,7	1,0	0,7	0,5	0,4	0,3	0,2	0,1