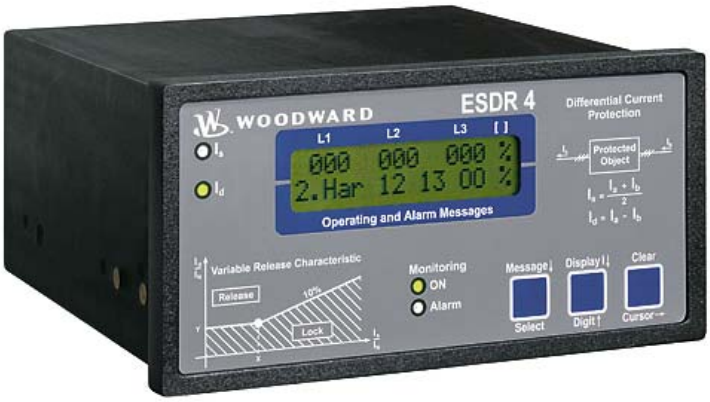
37138C

ESDR 4T
Current Differential Protection Relay



Manual

Manual 37138C

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment.

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

Revision History

Rev.	Date	Editor	Changes
NEW	02-11-26	Tr	Release
A	03-02-29	TP	Minor corrections
B	04-11-22	TP	Minor corrections
C	07-03-01	TP	Sealing parameters added; minor corrections

Contents

Figures and Tables

Figures

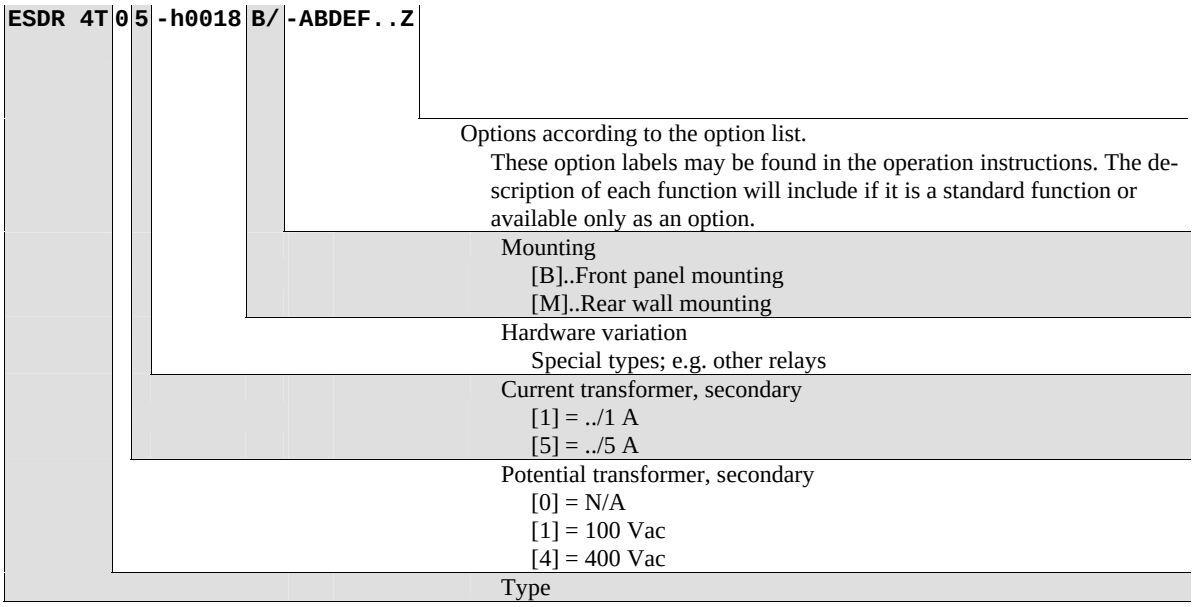
Chapter 1.
General Information

The ESDR 4T is a three-phase current differential protection relay for generators, motors and transformers in block connection (protected object). The currents flowing in the individual conductors are each measured using a current transformer on both sides of the protected object. They form the protection area boundary or zone. All two or three-phase short-circuits and line-to-earth faults within this protection area are detected by the ESDR 4T as fault currents which cause tripping. The unit does not trigger if fault currents occur outside the protection zone. In this way, a selective protection is guaranteed.

All 6 measuring currents are measured in electrical isolation. The unit calculates the differential current and restraint current internally for each phase separately. The following settings are taken into account for this:

- Transformer vector group
- Rated current of the protection object on the low-voltage side
- Rated primary current of the current transformer on the high and low-voltage side
- Voltage transformation of the transformer

The ESDR 4T consists of a basic unit plus various options. The model designation is determined as follows:



Examples:
ESDR 4T01B (standard unit, no voltage measuring and ../1 A CT input, for front panel mounting)

Intended Use The unit must only be operated for the uses described in this manual. The prerequisite for a proper and safe operation of the product is correct transportation, storage, and installation as well as careful operation and maintenance.

NOTE

This manual has been developed for a unit fitted with all available options. Inputs/outputs, functions, configuration screens and other details described, which do not exist on your unit may be ignored.

The present manual has been prepared to enable the installation and commissioning of the unit. Due to the large variety of parameter settings, it is not possible to cover every possible combination. Therefore, this manual is only a guide. In case of incorrect entries or a total loss of functions, the default settings can be taken from the enclosed list of parameters.

Chapter 2.
Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before performing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. **Opening the control cover may void the unit warranty.**
   Do not remove the Printed Circuit Board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

   - Ensure that the device is completely de-energized (all connectors must be disconnected).
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, connectors, or components with conductive devices with your hands.
   - When replacing a PCB, keep the new PCB in the protective antistatic bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the protective antistatic bag.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Chapter 3.
Wiring

CAUTION

A circuit breaker must be provided near the unit and in a position easily accessible to the operator. This must also bear a sign identifying it as an isolating switch for the unit.

NOTE

Inductive devices connected to the system (such as operating current coils, undervoltage tripping units, or auxiliary/power contacts) must be connected to a suitable interference suppressor.

The following chart may be used to convert square millimeters [mm²] to AWG and vice versa:

AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²
30	0.05	21	0.38	14	2.5	4	25	3/0	95	600MCM	300
28	0.08	20	0.5	12	4	2	35	4/0	120	750MCM	400
26	0.14	18	0.75	10	6	1	50	300MCM	150	1000MCM	500
24	0.25	17	1.0	8	10	1/0	55	350MCM	185		
22	0.34	16	1.5	6	16	2/0	70	500MCM	240		

Wiring Diagram

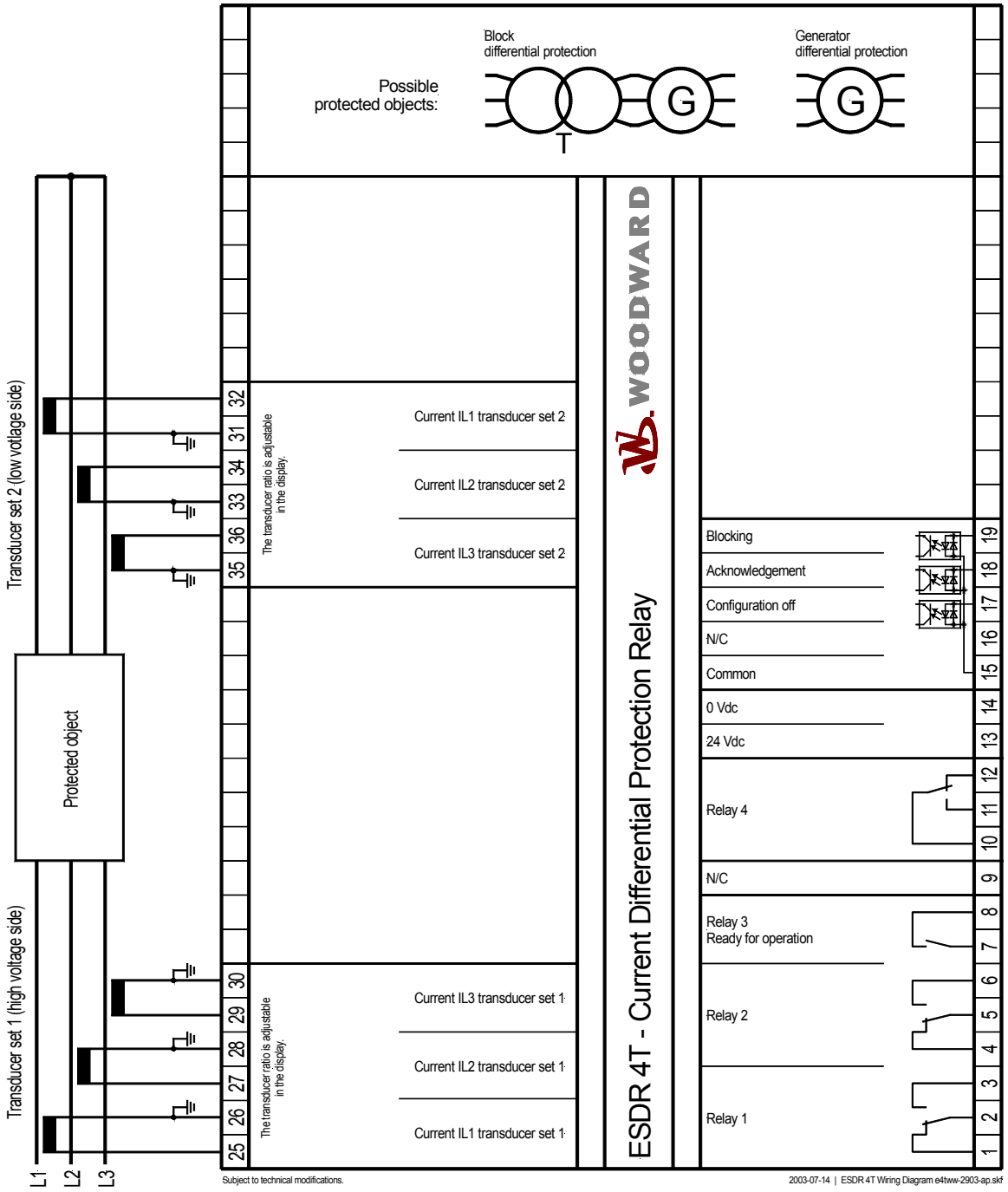


Figure 3-1: Wiring diagram

Power Supply

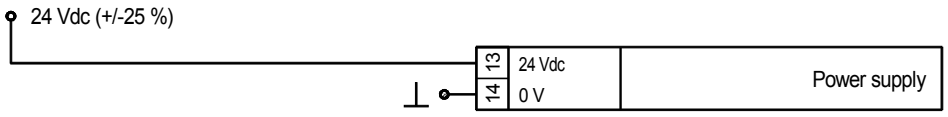


Figure 3-2: Power supply

Terminal	Description	A_{max}
13	+24 V DC, 10 W	2.5 mm²
14	0 Vdc reference voltage	2.5 mm²

Measuring Inputs

WARNING

Before detaching the secondary current transformer connections or those on the unit, you should ensure that the current transformer secondary is short-circuited.

NOTE

One side of the secondary of all CTs must be earthed. The earth connection should be made on the side of the secondary facing the protected object. The polarity of the CTs must be in accordance with the following diagram.

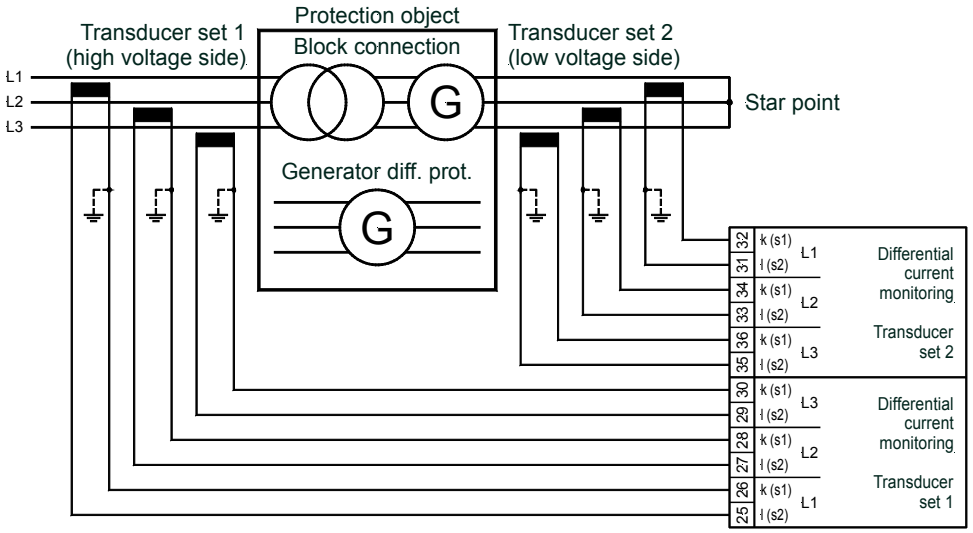


Figure 3-3: CT (transducer) inputs

Terminal	Measurement	Description	A_{max}
25	CT set 1 ../1 A or ../5 A	Measured current L1, Transducer input s2 (l)	4 mm²
26		Measured current L2, Transducer input s1 (k)	4 mm²
27		Measured current L2, Transducer input s2 (l)	4 mm²
28		Measured current L2, Transducer input s1 (k)	4 mm²
29		Measured current L3, Transducer input s2 (l)	4 mm²
30		Measured current L3, Transducer input s1 (k)	4 mm²
31	CT set 2 ../1 A or ../5 A	Measured current L1, Transducer input s2 (l)	4 mm²
32		Measured current L1, Transducer input s1 (k)	4 mm²
33		Measured current L2, Transducer input s2 (l)	4 mm²
34		Measured current L2, Transducer input s1 (k)	4 mm²
35		Measured current L3, Transducer input s2 (l)	4 mm²
36		Measured current L3, Transducer input s1 (k)	4 mm²

Discrete Inputs

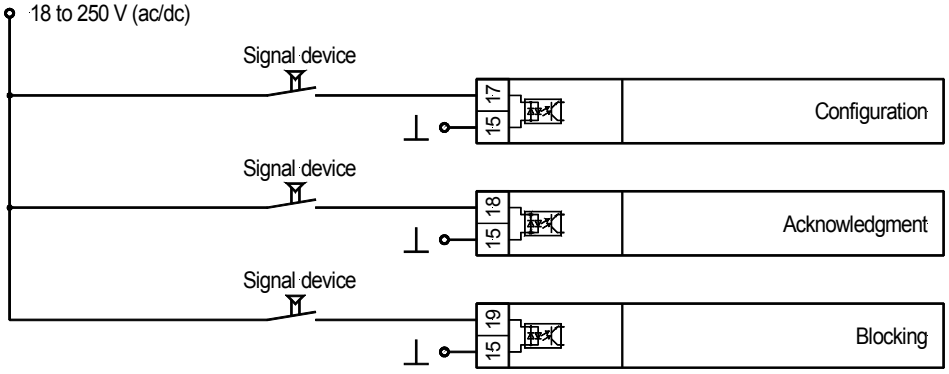


Figure 3-4: Discrete inputs

Terminal	Associated common	Description (according to DIN 40 719 section 3, 5.8.3)	A_{max}
A	***B***	**Make contact**	
17	15	Configuration off	2.5 mm²
18		Acknowledgement	2.5 mm²
19		Blocking	2.5 mm²

Relay Outputs

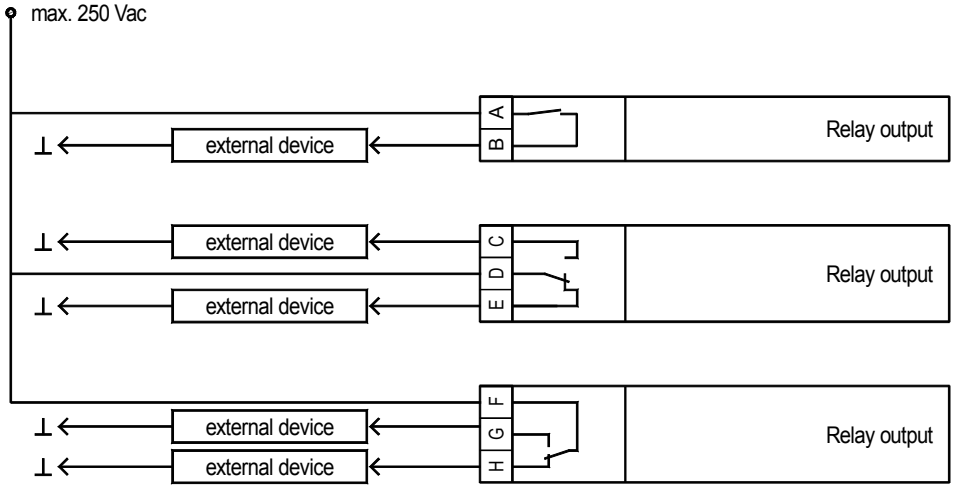


Figure 3-5: Relay outputs

Terminal			Description	A_{max}
Root ***A***		Make-contact ***B***		
7		8	Relay 3 - Ready for operation	2.5 mm²
Make-Contact	Root	Break-contact		
C	***D***	***E***		
3	2	1	Relay 1 - Trip	2.5 mm²
6	5	4	Relay 2 - Trip	2.5 mm²
Root	Make-contact	Break-contact		
F	***G***	***H***		
11	10	12	Relay 4 - Warning	2.5 mm²

Chapter 4.
Functional Description

Introduction

The ESDR 4T is a three-phase current differential protection relay for generators, motors and transformers in block connection (protected object). The currents flowing in the individual conductors are each measured using a current transformer on both sides of the protected object. They form the protection area boundary or zone. All two or three-phase short-circuits and line-to-earth faults within this protection area are detected by the ESDR 4T as fault currents which cause tripping. The unit does not trip if fault currents occur outside the protection area. In this way, a selective protection is guaranteed.

All 6 measuring currents are electrically isolated. The unit calculates the differential current and restraint current internally for each phase separately. The following settings are taken into account for this:

- Transformer vector group
- Rated current of the protection object on the low-voltage side
- Rated primary current of the current transformer on the high and low-voltage side
- Voltage transformation of the transformer

During the calculation, the star connections on the windings are arithmetically converted into delta layouts to eliminate the zero-sequence system. The different relationships between the current transformer ratios and the voltage transformation can lead to relatively different currents even when there are no faults. In order to manage defined ratios, the measured value on the high-voltage side is standardized so that it can be compared with the measured value on the low-voltage side. The reference side is the low-voltage side, therefore the configured rated current on the low-voltage side must be referred to. It is recommended that the generator rated current be used as the reference value for unit connections.

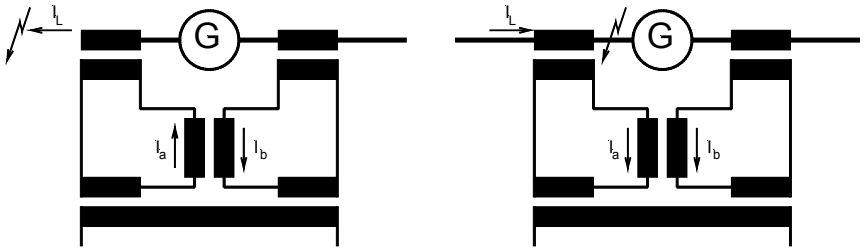
NOTE

The measured values of the differential protection are shown as percentage values related to the configured rated current.

The unit monitors six (6) measured currents via isolated inputs. The unit calculates internally the restraint current (I_s) and the differential current (I_d) separately for each phase. The actual values of the calculated parameters (Differential current I_d und Restraint current I_S) are shown on the display either as absolute values or as a percentage of the generator rated current (selectable in locked input mode).

Theoretically the currents I_a and I_b are equal, both in fault-free operation and outside the protection zone (Figure 4-1-a).The difference is zero and the differential protection does not initiate. However, in practice current differentials do occur (= spurious currents), even in fault-free operation. They result, for example, from summation or phase angle errors in the CTs, which are influenced by deviating burden values. These spurious currents remain small inside the operating range, but increase with increasing load and are especially high when one or more CTs become saturated (e.g. in the case of an external short circuit). In order to prevent a tripping of the relay due to spurious currents, the trigger threshold is not held statically constant but increases in relation to the restraint current I_s. Spurious currents need to be taken into account when adjusting the trip characteristic.

When a fault occurs inside the protection area (Figure 4-1-b), unequal currents flow in the CTs, which result in a current differential. If this exceeds the differential protection threshold, the relay will trip.



a) b)

Schematic circuit diagrams (single phase version):
a) Fault outside the protection area
b)Fault inside the protection area

Figure 4-1: Protection principle

The circuit diagram above serves to explain the protection concept for in phase and equal currents. The differential current and restraint currents are determined arithmetically.

Measurement Inputs

The unit records six current values for the current differential protection.

For differential current measurement, the unit forms the sum of two values (restraint current I_S) and the deviation (differential current I_d). The actual value of the values determined (differential current I_d and restraint current I_S) is shown as a percentage on the display with reference to the rated current.

Differential Current Monitoring

The monitoring of the differential current is carried out in two stages.

The first monitoring stage serves as a warning and can be enabled or disabled. Should the adjustable warning characteristic be exceeded, a text appears in the display and a relay contact is enabled. The pick-up time and the dropout delay of the relay output are adjustable. The warning stage of the monitoring is auto-resetting.

The second stage of monitoring (main stage) serves to initiate tripping. In contrast to the first stage, it offers the possibility to monitor the overstepping of an adjustable tripping characteristic ($I_d < I_n$) and additionally, a fixed tripping-threshold of 100%, relative to the generator rated current ($I_d > I_n$). The trigger-delay for each limit value may be independently adjusted, thus allowing a shorter triggering time at higher differential currents. When one or both tripping characteristics are exceeded, a text display is initiated and two relay contacts are energized. The tripping characteristics possess a 2% hysteresis relative to the generator rated current.

The signal relay is only automatically reset if the function "auto-acknowledge relay" in the Entry field on the screen is configured to "ON". Otherwise, the resetting is carried out by pressing the "Clear" button on the front of the unit or via the discrete input terminal 18 "Reset".

Tripping Characteristic

The following figure shows the tripping and warning characteristics (with sample values for X12, Y1,and Y2). It represents the tripping and warning thresholds (Y) relative to the restraint current (X) The coordinates P (X12/Y2) and P (X12/Y1) the positions of the corner points. The selection of these positions is dependent on the generator being protected. The following gives the ranges of tripping and warning thresholds:

I_S / I_N	0 to X12	The threshold I_d is independent of the restraint current..
I_S / I_N	X12 to $5 \times I_N$	The threshold I_d is dependent on the restraint current. A change of 100% in the restraint current causes an increase of 10% in the tripping threshold.
I_S / I_N	$> 5 \times I_N$	The threshold I_d stays constant at 85%.

Different characteristics can be chosen for the first and second monitoring levels, whereby the horizontal position (X-coordinate) is valid for both stages. The vertical position (Y-coordinate) can be chosen separately for each monitoring level. This results in a fixed difference in thresholds of the first and second monitoring levels for each restraint current I_s.

The unit can measure currents up to $5 \times I_N$ accurately. Depending on the vector group there can be a deviation in measuring the different currents and the unit can trip. The message "range exceeded" is displayed when tripping due to these currents occurs. Currents larger than $5 \times I_N$ will only result in tripping if a short circuit is within the protected area. If the short circuit is outside the protection area, only the generator would be drive the currents measured by the CTs.

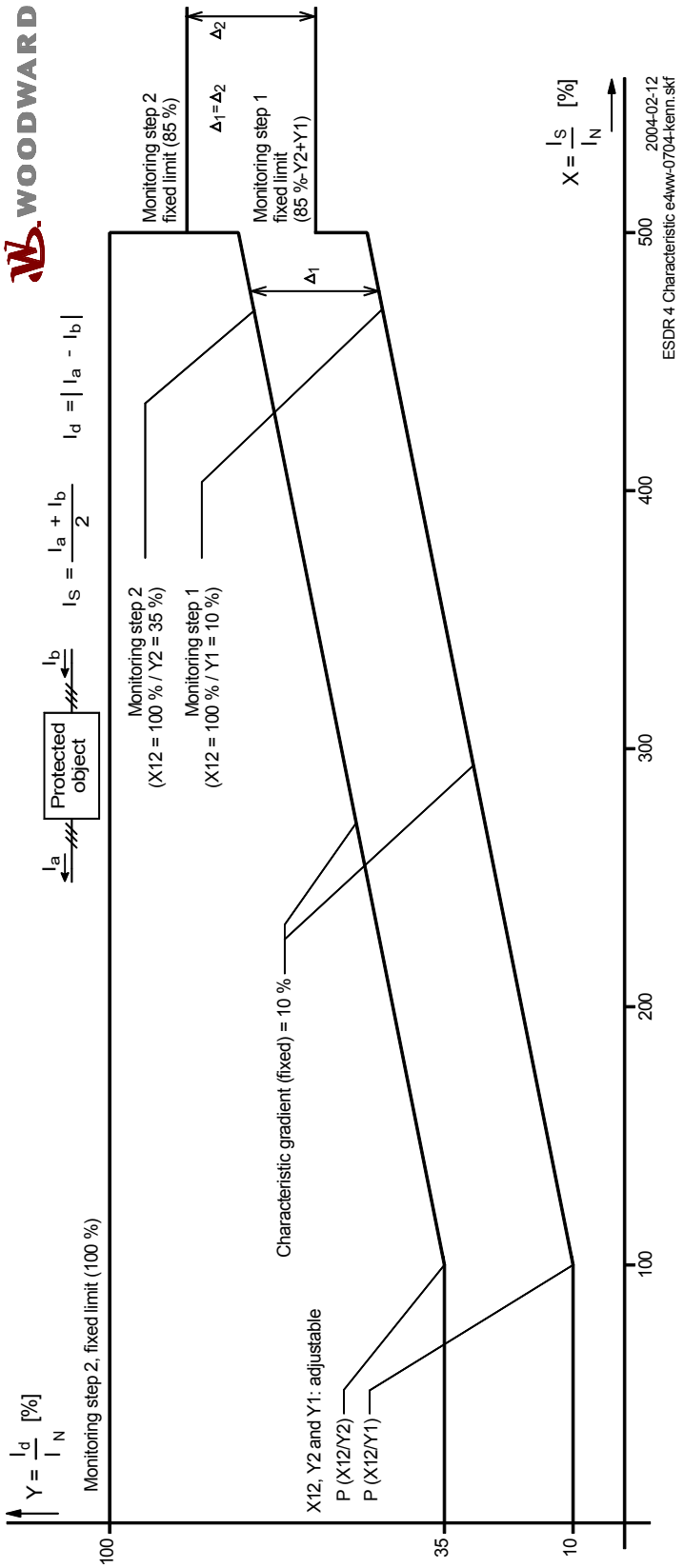


Figure 4-2: Characteristic

Electrical Restraint of Inrush Current and Overexcitation with Transformers

Certain transformer operational conditions can cause differential currents without there actually being a fault present at the protected object. This includes energizing the transformer and operating in overexcitation mode. When a transformer is energized, a current inrush flows in on one side which can be variably high depending on the instantaneous value of the supply current. If a long high-voltage line has a transformer at the end that is being energized, overvoltages can occur and overexcite the transformer, inducing increased currents on one side. As the currents only flow one-sided in both cases, a differential current will be measured which results in false tripping.

During an inrush current there are typically high proportions of 2nd order harmonics present. However during overexcitation there are predominantly 5th order harmonics present. The harmonics component is determined in the ESDR 4T using the digital Fourier transformation (= DFT) and this is used as the criteria for electrical restraint against false tripping.

To activate the electrical restraint of an inrush current or an overexcitation, enable the "Stabilization Rush" function in the configuration mode by configuring as ON and set an operate margin in the next screen. The operate margin must be set for rush detection. This limit must be set so that it is not exceeded in normal operation. But it must be exceeded if an inrush current occurs. The proportion of 2^{nd} harmonics in normal operation and in the starting current depends in part on the type of transformer construction and the starting torque. As such, no general operate margin can be given here. The documentation contains notes stating that the proportion of 2^{nd} order harmonics when there is inrush current is always over 50 % and always under 30 % when there is a short-circuit. Only step 1 of the differential current tripping can be stabilized; step 2 causes constant tripping. When electrical restraint is activated you should ensure that the time lag for monitoring the differential current 1 is at least 0.08 seconds.

Self-Monitoring

The unit is equipped with an operational readiness message for self-monitoring. It is available externally via a contact assembly. The ready for operation signal is disabled if the unit's supply voltage drops below approximately 19 Vdc or if there is an internal malfunction.

Configuration

The operating parameters may be entered in through the buttons on the front panel. To change these parameters, the control must be in the configuration mode. The control unit will continue to operate while in the configuration mode. This may result in the control unit accidentally issuing a breaker open command if the parameters are changed while in the operation mode.

Inputs and Outputs

Control Inputs

Configuration off
Terminal 17

When this input is energized, the unit remains in Display mode and cannot be changed to Configuration mode. The Configuration mode is enabled if this terminal is de-energized.

Acknowledgement
Terminal 18

If this input remains energized for at least 1 s, the faults detected in monitoring level 2 are reset. This means that the relays will be de-energized and the text display will be deleted from the screen as long as the monitored currents are not exceeding the configured threshold level.

Blocking
Terminal19

When this input is energized, the differential protection is disabled. This means that the differential current is not monitored, relays cannot be enabled and text is not displayed.

Relays

Relay 1
Terminals 1/2/3

The function of this relay may be configured. Refer to Configuring the Relay on page 25 for details.

Relay 2
Terminals 4/5/6

The function of this relay may be configured. Refer to Configuring the Relay on page 25 for details.

Ready for operation (Relay 3)
Terminals 7/8

This relay is enabled when the unit is operational and the differential current is being monitored. The relay becomes disabled if the monitoring is deactivated through any of the following reasons:

- the internal self-monitoring has detected a malfunction of the unit. A correct functioning of the unit cannot be guaranteed and corrective action may be necessary.
- the digital input "Blocking" is energized
- the parameter "Monitoring" is configured to "Off"

An additional function may be assigned to this relay. Refer to Configuring the Relay on page 25 for details.

Relay 4
Terminals 10/11/12

The function of this relay may be configured. Refer to Configuring the Relay on page 25 for details.

Chapter 5.
Display and Operating Elements

The foil covering of the front panel consists of coated plastic. All keys are comprised of touch sensitive membrane elements. The display is a Liquid Crystal display (LC-display), comprised of two rows of text that are 16 characters each and are indirectly illuminated (green). The contrast of the display can be continuously adjusted by means of a rotary potentiometer on the left hand side.

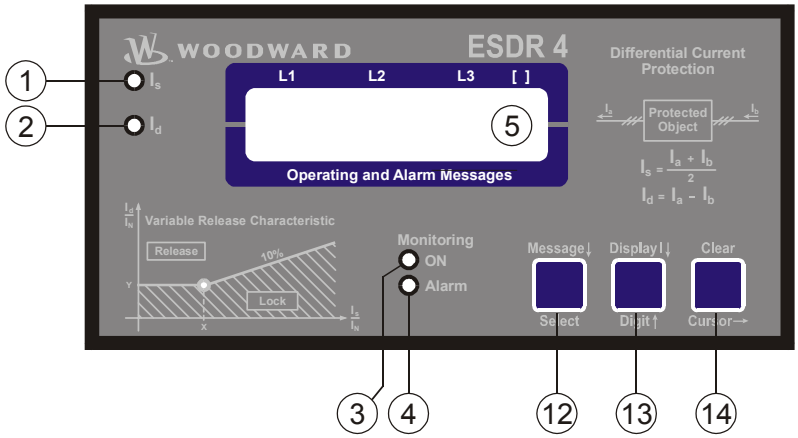


Figure 5-1: Front panel

Short Description of LEDs and Buttons

LEDs

No..	Designation	Function
1	I_S	Restraint current
2	I_d	Differential current
3	Monitoring ON	Monitoring activated
4	Alarm	Alarm initiated

Buttons

No.	Designation	Function
12	Message↓	Scroll message
12	Select	Confirm selection
13	Display↓	Scroll display
13	Digit↑	Increase digit
14	Clear	Clear (Reset) of fault message
14	Cursor→	Move cursor one position to the right

Miscellaneous

No.	Designation	Function
5	LC-Display	LC-Display

LEDs

1 **I_S** Color: green

Restraint current I_s

The actual values of the restraint current I_s are visible in the display

2 **I_d** Color: green

Differential current I_d

The actual values of the differential current I_d are visible in the display.

3 **Monitoring ON** Color: green

Monitoring

ON ..... Monitoring is active.
OFF ..... Monitoring is deactivated through entry "Monitoring Off", through activation of discrete input terminal 19 "Blocking" or through wrong configuration of "CT-ratio" or "Generator current".

4 **Alarm** Color: red

Alarm

The threshold for differential current monitoring in level 2 is or was exceeded. This message remains displayed until it is reset.

Buttons

The display can appear in two different modes: display mode or configuration mode. Pressing the "Display/Digit↑" and "Clear/Cursor→" buttons simultaneously changes the control unit from one mode to the other.

If the digital input terminal 17 "Configuration off" is energized, the display changes into Display mode and cannot be changed to configuration mode. If this digital input will be de-energized again, the display changes back to configuration mode.

In order to facilitate the setting of the parameters, the buttons have an AUTOSCROLL function. It allows the user to advance to the next configuration screen, digit, or cursor position more rapidly. The AUTOSCROLL function will only be enabled once the user depresses and holds the corresponding key.

12 **Message↓ / Select**

Message↓ / Select

Display mode: Message↓ - Pressing this button advances the display through the operating and alarm messages. The alarm messages are displayed in the order in which they were generated.
Configuration mode: Select – By pressing this button the user advances to the next parameter. If any changes are made to the configured value by pressing either the "Digit↑" or "Cursor→" buttons, the new value must be saved to the controller by pressing the "Select" button once. If this button is pressed again, the display will advance to the next parameter.

13 **Display V↓ / Digit↑** **Display V↓ / Digit↑**

Display mode: Display V↓ -By pressing this button, the monitored values of the restraint current I_s and the differential current I_d are shown alternately in the top line of the display (the LEDs indicate which is being currently displayed).

Configuration mode: Digit↑ - By pressing this button, the number above the cursor is increased by one digit. The value cannot be configured outside the permissible adjustment limits defined in Appendix B: List of Parameters If the highest permissible value is reached, the value will automatically revert to the lowest permissible number.

14 **Clear / Cursor →** **Clear / Cursor →**

Display mode: Clear - The alarm text in the LC-display is deleted if this button is pressed and held for 3 seconds and no alarm condition is present.

Configuration mode: Cursor→ - The cursor is moved one position to the right by pressing this button. The cursor will automatically move to the extreme left position of the value to be changed when the cursor reaches the extreme right and the button is pressed again.

LC-Display

5 **LC-Display** **LC-Display**

Messages and values are displayed depending on the selected mode.

In the configuration mode, the unit's parameter values can be viewed and edited (see Chapter "Parameter"). In Display mode, the measured values and alarms are displayed.

Top Line
displays I_s and I_d.

Bottom Line
Normal condition: blank or display of the harmonics (maximum values)

Message list:

Fault condition	Fault message
Differential current in Phase L1 exceeds the warning threshold (monitoring level 1)	L1: Diff.curr 1
Differential current in Phase L2 exceeds the warning threshold (monitoring level 1)	L2: Diff.curr 1
Differential current in Phase L3 exceeds the warning threshold (monitoring level 1)	L3: Diff.curr 1
Differential current in Phase L1 exceeds the tripping threshold (monitoring level2)	L1: Diff.curr 2
Differential current in Phase L2 exceeds the tripping threshold (monitoring level2)	L2: Diff.curr 2
Differential current in phase L3 exceeds the tripping threshold (monitoring level 2)	L3: Diff.curr 2
Differential current in Phase L1 exceeds the rated current (monitoring level 2)	L1:Idiff.2 Id>In
Differential current in Phase L2 exceeds the rated current (monitoring level 2)	L2:Idiff.2 Id>In
Differential current in Phase L3 exceeds the rated current (monitoring level 2)	L3:Idiff.2 Id>In
Current in Phase L1 low voltage side exceeds 5 times the rated current (1A or 5A)	L1: range Ius>
Current in Phase L2 low voltage side exceeds 5 times the rated current (1A or 5A)	L2: range Ius>
Current in Phase L3 low voltage side exceeds 5 times the rated current (1A or 5A)	L3: range Ius>
Current in Phase L1 high voltage side exceeds 5 times the rated current (1A or 5A)	L1: range Ios>
Current in Phase L2 high voltage side exceeds 5 times the rated current (1A or 5A)	L2: range Ios>
Current in Phase L3 high voltage side exceeds 5 times the rated current (1A or 5A)	L3: range Ios>

These alarm texts are displayed sequentially by pressing the Message↓ button repeatedly. After the last alarm message has been displayed, the controller returns to the monitoring screen.

Chapter 6.
Configuration

Introduction

When in configuration mode (simultaneous pressing of "Digit↑" and "Cursor→"), the configuration screen can be advanced by pressing the "Select" button. A scroll function to rapidly advance through the parameters or increasing values can be enabled by pressing and holding the desired button. If the desired parameter was missed while advancing through the screens, the user may back up through a maximum of the last four screens by pressing the "Select" and "Cursor→" buttons. Should there be no entry, parameter change or other action for 60 seconds, the unit will automatically revert into Display mode.

During the configuration mode, the monitoring function is still enabled. This means inevitably, that while adjusting parameters during operation, it is possible to cause a relay to trip.

Basic Data

```
SPRACHE/LANGUAGE
----------------
```

Language selection **english/german**

The screens can be displayed in German or English.

```
Adjust settings
[Press "select"]
```

Configuration mode **"Select" button**

Pressing the "Select" key activates the configuration mode, and the following parameters can be enabled or changed within the given limits. Please you note that as you advance through the configuration screens, by configuring some parameters as "ON", additional screens must be configured relating to that parameter. If the parameter is configured as "OFF", the additional screens will be disabled and not displayed.

```
Software version
```

Software version

Displays the software version.

Configuration Access

NOTE

If no protection against modification of the setting values is required, we recommend to disable the sealing function. If a sealing function is necessary, we recommend to enable it after the setup is complete!

➔ Refer to the SEQUENCE DIAGRAM on Figure 6-1 at page 26!

By entering a five-digit code number, the configuration can be protected from unauthorized access and modifications. The function represents the exact software emulation of a mechanical seal. Unauthorized access will break the seal.

```
Coding (seal)
             ON
```

Sealing function **ON/OFF**

ON..... The configuration of the following parameters is protected by a code. The subsequent screens of this option will be displayed.

OFF..... The sealing function is disabled and the subsequent screens of this function are not displayed (default).

```
Code no. 000
Code?      ?????
```

Code for seal No. XXX **00000 bis 60000**

Enter the code for the seal here. The unit will behave as follows depending on the correctness of the code:

Correct code If the code for the active seal has been entered correctly, the following screens are skipped and the user may proceed to configure the parameters. The default code is "00100".

Wrong code. If the code for the active seal has been entered incorrectly, the following screens will be displayed.

```
Incorrect entry!
[Next: SELECT]
```

Incorrect code has been entered **"Select" button**

The code for the active seal has been entered incorrectly! Confirm this message using the "Select" button.

```
Code  no. 000
Break?       YES
```

Breaking the seal number XXX **YES/NO**

YES..... The seal will be broken and the user may proceed to configure the parameters. The seal number will be increased by 1. This enables to verify that unauthorized access has occurred.

NO..... You return to the code entry screen. You may only exit the sealing function by terminating the configuration mode (simultaneous pressing of "Digit↑" and "Cursor→").

```
Code no. 000
New code:  ?????
```

Code for seal 001 (new entry) **00000 to 60000**

After the old seal has been broken, the unit requests the code for the new seal. Sealing can now be effected with a new code.

```
Enter value
[Next: SELECT]
```

Enter values **"Select" button**

Press the "Select" button to proceed with the configuration.

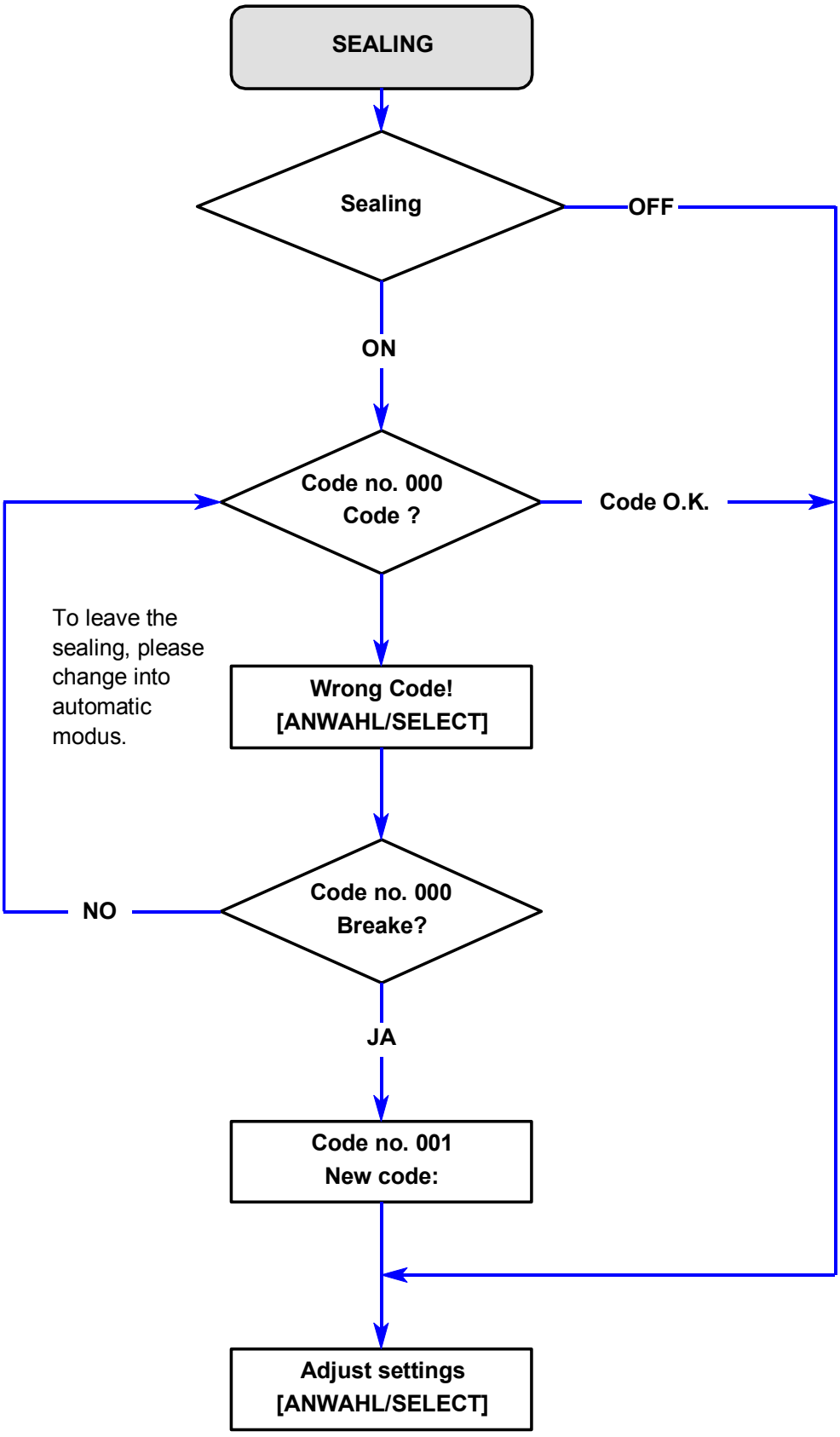


Figure 6-1: Sealing

Configuring the Relay

NOTE

- **Operating current (N.O.): The relay is enabled (i.e. in the operating state) when current flows through the coil. If a loss of the supply voltage occurs, a change of state will not occur in the relay and no triggering of fault conditions occur. In this mode of operation the condition of the system should be monitored through other means than the state of the relay.**
- **Idle current (N.C.): The relay is disabled (i.e. in idle state) when current flows through the coil. The relay is energized in idle state. If a loss of the supply voltage occurs, a change of state will occur in the relay and a triggering of fault conditions will occur.**

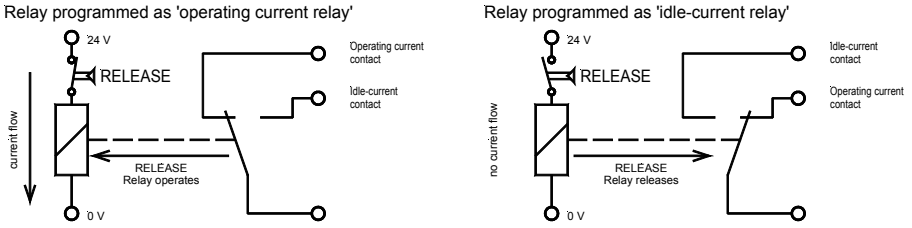


Figure 6-2: Operating/idle current

```
Change relay-
function?    YES
```

Change relay function? **YES/NO**

YES..... The subsequent screens for the selection between operating current and idle current contact are displayed.
NO..... The subsequent screens are not displayed.

```
Funct. rel.   12
(R=releases)  AA
```

```
Funct. rel.   34
(R=releases)  RA
```

Relays 1, 2, 3 and 4 functions **A/R**

A choice is made between different control principles with the selection of either operating current contact (N.O.) or idle current contact (N.C.). An operating current output can be used if an open circuit cannot lead to more serious faults; idle current output performs advanced tasks, e.g. for lines relevant to safety. Relay 3 (readiness for operation) can only be operated as an idle current contact.
A..... Operating current output (N.O.): the digital alarm output functions as an operating current output.
R..... Idle current output (N.C.): the digital alarm output functions as idle current output.
Note:..... The alarm outputs for differential protection are changeover contacts.

```
Auto-acknowledge
relay          ON
```

Self-acknowledging relay **ON/OFF**

(Description for operating current output)
ON..... The relay is automatically enabled (after the configured delay time has expired), once the fault condition is no longer detected. Depending on how the parameter "**`Self-acknowledging messages`**" is configured, will dictate how the control displays the error messages.
OFF..... The relays remain disabled and the messages are shown in the display until they have been acknowledged manually. The subsequent screens of this parameter will not be displayed.
NOTE ..... Subsequent setting is blocked:
- "**`Self-acknowledging relay`**" "**`OFF`**"
- "**`Self-acknowledgement of messages`**" "**`ON`**"

```
Release delay
Diff.curr.00,00s
```

Resetting time of differential current **0.10 to 99.98 s**

Only visible if the "Self-acknowledging relay" screen is configured to ON.

```
Auto-acknowledge
messages      ON
```

Self-acknowledging messages **ON/OFF**

ON .....Once the fault condition is no longer detected and the message resetting time has expired, the message is cleared from the display.
OFF .....The messages are shown in the display until they have been manually acknowledged. The subsequent screen is not displayed..
NOTE.....Subsequent setting is blocked:

- "**Self-acknowledging relay**" "**OFF**"
- "**Self-acknowledgement of messages**" "**ON**"

```
Acknowledge
message aft. 00s
```

Acknowledge messages delay time **1 to 99 s**

The fault messages are acknowledged after the configured delay time expires. This timer is initiated when the measured values return to the configured limit + hysteresis.

NOTE

The following screens are used to assign the warning messages to the relays 1 to 4. The number of the relay to be enabled when the respective set point is exceeded has to be configured. If left as all 0s no message will be issued. It does not matter what order the relay numbers are entered as. As an example, if 2310 or 3102 is configured, relays 1,2, and 3 will react when this set point is exceeded.

Relay 3 is always connected to the "Ready for operation" message.

```
Diff.current 1
relay outp. 0000
```

Differential current 1 output by relay **0 to 4**

If the differential current level 1 has been exceeded, the relay output(s) assigned here will be enabled.

```
Diff.current 2
relay outp. 0000
```

Differential current 2 output by relay **0 to 4**

If the differential current level 2 has been exceeded, the relay output(s) assigned here will be enabled.

```
Range monit. Id
relay outp. 0000
```

Range exceeded message output by relay **0 to 4**

If the current exceeds 5 × I_N, the relay output(s) assigned here will be enabled.

```
inrush detected
relay outp. 0000
```

Inrush recognition output by relay **0 to 4**

If the threshold value of the 2nd harmonics is exceeded, the relay output(s) assigned here will be enabled. This output is only intended for diagnostics and commissioning purposes.

Nominal Data

General Data

```
Nominal current
          0000A
```

Rated current of the protected object **10 to 9,999 A**

This value is used as reference value for the calculation and display of restraint current and differential current. The entered value of the generator current must be at least 60% of the nominal current of the CT and must not exceed the entered value of CT nominal current. You must enter the rated current of the low-voltage side when implementing transformer or block differential protection.

Example: ..... CT ratio 500/5 A
Range of rated current 300 A to 500 A

Data for Differential Protection

```
Curr. transf. Id
high vol.  0000A
```

Primary value (high-voltage side) of the current transformer **10 to 9,990 A**

Entry of the current transformer ratio is necessary. The ratio must be selected so that during normal operations, the secondary side of the CT is operating at least at 60% of the transformer's capacity when at maximum current. A smaller current transformer ratio would cause inaccuracies in the monitoring functions.

```
Curr. transf. Id
low vol.   0000A
```

Primary value (low-voltage side) of the current transformer **10 to 9,990 A**

Entry of the current transformer ratio is necessary. The ratio must be selected so that during normal operations, the secondary side of the CT is operating at least at 60% of the transformer's capacity when at maximum current. A smaller current transformer ratio would cause inaccuracies in the monitoring functions.

```
Nominal voltage
high vol 000,0kV
```

Rated voltage primary value (high-voltage side) **0.4 to 750.0 kV**

The transformer conversion ratio is calculated using this value. This value is the same as the rated voltage on the low-voltage side when the device is being used for generator differential protection.

```
Nominal voltage
low vol  000,0kV
```

Rated voltage primary value (low-voltage side) **0.4 to 750.0 kV**

The transformer conversion ratio is calculated using this value. This value is the same as the rated voltage on the high-voltage side when the device is being used for generator differential protection.

```
Vector group
             000
```

Transformer vector group

The transformer vector group can be set in this screen. Vector group Dd0 should be set when the device is being used purely as generator differential protection.

The following applies: HV = high-voltage side
LV = low-voltage side.

Vector group	
Yd5	HV: ⅄-circuit arrangement, LV: Δ-circuit arrangement, 5 × 30 ° = 150 °
Yy0	HV: ⅄-circuit arrangement, LV: ⅄-circuit arrangement, 0 °
Dy5	HV: Δ-circuit arrangement, LV: ⅄-circuit arrangement, 5 × 30 ° = 150 °
Dd0	HV: Δ-circuit arrangement, LV: Δ-circuit arrangement, 0 °
Yz5	HV: ⅄-circuit arrangement, LV: Z-circuit arrangement, 5 × 30 ° = 150 °
Dz0	HV: Δ-circuit arrangement, LV: Z-circuit arrangement, 0 °
Yd11	HV: ⅄-circuit arrangement, LV: Δ-circuit arrangement, 11 × 30 ° = 330 °
Yy6	HV: ⅄-circuit arrangement, LV: ⅄-circuit arrangement, 6 × 30 ° = 180 °
Dy11	HV: Δ-circuit arrangement, LV: ⅄-circuit arrangement, 11 × 30 ° = 330 °
Dd6	HV: Δ-circuit arrangement, LV: Δ-circuit arrangement, 6 × 30 ° = 180 °
Yz11	HV: ⅄-circuit arrangement, LV: Z-circuit arrangement, 11 × 30 ° = 330 °
Dz6	HV: Δ-circuit arrangement, LV: Z-circuit arrangement, 6 × 30 ° = 180 °

Differential Protection

```
Differential
protection    ON
```

Differential protection **ON/OFF**

ON .....Monitoring of the differential current is enabled and the following screens of this option are displayed.
OFF .....The monitoring is disabled and the following screens are not displayed.

NOTE

The following screens are only visible if the differential protection is enabled. These screens do not appear if the monitoring is set to OFF.

Modifying the Tripping Characteristic

```
Release value
Is/In     X=000%
```

Trigger Value I_S/I_N (X2) **50 to 300 %**

Definition of the threshold characteristic for the monitoring of levels 1 and 2.

This value determines the horizontal position (X2 coordinates of points P [X2/Y1] and P [X2/Y2]) of the significant point on the trip and warning characteristic curve.

```
Diff. current  1
Id/In     Y=000%
```

Limit value $I_d<I_N$ (Monitoring level 1, Y1) **0 to 300 %**

This value determines the vertical position (Y1 coordinate) of the significant point P [X2/Y1] on the warning characteristic curve (monitoring step 1). The horizontal position is identical to the tripping characteristic. The warning limit value is usually set lower than the tripping limit value.

```
Diff. current 1
Delay     00,00s
```

Time lag for monitoring step 1 **0.02 to 99.98 s**

The threshold value for the differential current 1 must be exceeded for at least the period of time indicated in this screen for tripping to occur. This value should be set to at least 0.08 seconds when electrical restraint of inrush current or over excitation is activated.

```
Diff. current  2
Id/In     Y=000%
```

Limit value $I_d<I_N$ (monitoring step 2, Y2) **0 to 300 %**

This value determines the vertical position (Y2-coordinate) of the significant point P [X2/Y2] on the tripping characteristic (monitoring step 2).

```
Diff. current  2
T1(Id<In) 00,00s
```

Time lag $I_d<I_N$ (monitoring step 2) **0,02 to 99,98 s**

The threshold value for the differential current 2 must be exceeded for at least the period of time indicated in this screen for tripping to occur. The set time applies to differential currents lower than 100 %.

```
Diff. current  2
T2(Id>In) 00,00s
```

Time lag $I_d>I_N$ (monitoring step 2 [rapid trip step]) **0,02 to 99,98 s**

The threshold value for the differential current 2 must be exceeded for at least the period of time indicated in this screen for tripping to occur. The set time applies in the case of very large differential currents occurring which are larger than 100 % (rapid trip step).

```
Diff. current
Hysteresis  000%
```

Differential current hysteresis **1 to 240 %**

To prevent the signal relay constantly being opened and closed in the proximity of the set threshold value, you can enter the percentage differential between the pickup and release value (hysteresis), referring to the rated current I_N.

Modifying the Electrical Restraint

```
Stabilisation
Rush          ON
```

Electrical restraint with inrush current **ON/OFF**

ON .....As soon as the proportion of 2nd order harmonics exceeds the limit configured in the parameter "Release value Rush", tripping of the differential current 1 is restrained. The subsequent screens will be displayed.

OFF .....No restraint occurs with the inrush current, and the subsequent screens of this option are not displayed.

```
Release value
Rush          00%
```

Operating limit of electrical restraint with inrush current **10 to 50 %**

The operating limit is a measure for the sensitivity of the electrical restraint. The setting depends on the characteristics of the transformer being protected and the network configuration.

```
Stabilisation
Overexcit.    ON
```

Electrical restraint with over excitation **ON/OFF**

ON .....As soon as the proportion of 5th order harmonics exceeds the limit configured in the parameter "Release value Overexcit.", tripping of the differential current 1 is restrained. The subsequent screens will be displayed.

OFF .....No restraint occurs with over excitation, and the subsequent screens of this option are not displayed.

```
Release value
Overexcit.    00%
```

Operating limit of electrical restraint with over excitation **10 to 50 %**

The operating limit is a measure for the sensitivity of the electrical restraint. The setting depends on the characteristics of the transformer being protected and the network configuration.

```
Rated frequency
        00Hz
```

Rated frequency **50/60 Hz**

Entering a value here specifies the rated frequency. The rated frequency is used to calculate the harmonic vibrations.

```
Display
harmonics     OFF
```

Display of harmonics **ON/OFF**

ON .....The maximum values of the 2nd and 5th order harmonics are displayed in the second line in display mode. The indicated values are always plotted according to the highest value displayed and can be useful in setting up. The values indicated are reset to zero by pressing the acknowledgement button.

OFF .....The proportion of harmonics is not displayed.

Chapter 7.
Commissioning

DANGER - HIGH VOLTAGE

When commissioning the control, please observe all safety rules that apply to the handling of live equipment. Ensure that you know how to provide first aid in the event of an uncontrolled release of energy and that you know where the first aid kit and the nearest telephone are. Never touch any live components of the system or on the back of the system.

LIFE THREATENING

CAUTION

Only a qualified technician may commission unit. The "EMERGENCY-STOP" function must be operational prior to commissioning of the system, and must not depend on the unit for its operation.

CAUTION

Prior to commissioning ensure that all measuring devices are connected in correct phase sequence. The connect command for the unit circuit breaker must be disconnected at the unit circuit breaker. The field rotation must be monitored for proper rotation. Any absence of or incorrect connection of voltage measuring devices or other signals may lead to malfunctions and damage the unit, the engine, and/or components connected to the unit!

Prerequisite

Connect the unit according to the wiring diagram on Page 9.

Pre-Adjustments

In order to put the unit into operation, you must

1. Connect the auxiliary 24Vdc power supply (Terminals 13/14)
2. Activate the configuration mode (Press "Digit↑" and "Cursor→")
3. Set all parameters according to the Chapter "Configuration"
4. Activate the Display mode (Press "Digit↑" and "Cursor→")

Testing with Secondary Values

The threshold value can be tested using three-phase test equipment. Single-phase test systems can generate measured values which do not match the current supplied as a result of eliminating the phase-matching system. The control unit will behave in a similar manner to applications where matching transformers are used.

Differential Current Testing Using Single-Sided Three-Phase Supply

The operating limit can be approached by slowly increasing the test current. The tests can be carried out consecutively on the high and low-voltage sides.

Threshold value: the threshold value in A is generated from the following ratio

$$I_{d(a)} = \frac{I_{W(\sec)}}{I_{W(prim)}} \cdot \frac{I_{d(ESDR)}}{100\%} \cdot \frac{I_N}{k_B}$$

$I_{d(ESDR)}$ Differential current setting value [%]
$I_{w(prim)}$ Primary transformer rated current [A]
$I_{w\,(sec)}$ Secondary transformer rated current [A]
$I_{d(a)}$ Differential current threshold value
I_N Rated current of the protection object (reference value)
k_B Reference factor

Reference factor k_B: the reference factor is used for standardization on the reference side.

Low-voltage side: $k_B = 1$

High-voltage side: $k_B = \frac{V_{Tr(HV)}}{V_{Tr(LV)}}$

$V_{TR(LV)}$ Transformer rated voltage (low-voltage side)
$V_{TR(HV)}$ Transformer rated voltage (high-voltage side)

Example:

$I_{d(ESDR)}$ 20 % = 0.2
$I_{w(prim,\,HV)}$ 100 A
$I_{w\,(sek,\,HV)}$ 5 A
$I_{w(prim,\,LV)}$ 400 A
$I_{w\,(sek,\,LV)}$ 5 A
$U_{Tr(HV)}$ 20.0 kV
$U_{Tr(LV)}$ 6.3 kV
I_N 350 A

$$k_B = \frac{20.0kV}{6.3kV} = 3{,}175$$

Low-voltage side: $I_{d(a,LV)} = \frac{5A}{400A} \cdot \frac{20\%}{100\%} \cdot \frac{350A}{1} = 0.875A$

High-voltage side: $I_{d(a,HV)} = \frac{5A}{100A} \cdot \frac{20\%}{100\%} \cdot \frac{350A}{3.175} = 1.10A$

Commissioning Using Primary Values

Prior to commissioning a unit, the following must be verified:

- All test equipment must be removed from the system
- There are no open circuits on any current transformer

During commissioning, the system should be configured to permit for the finest current adjustment. This can be accomplished by:

- Utilizing suitable jumpers (observe current carrying capacity) for unit connections on the high-voltage side of the transformer
- Disabling the automatic voltage regulator and manually adjusting the excitation current

Testing for Correct Connection

The excitation should be set so that the generator is loaded to approx. 20% rated current. If the connections are correct, the displayed differential current should be approximately zero. The displayed restraint current should be checked using an external measuring device. Record all measured values.

Restraint current $$I_{s(a)} = \frac{I_{W(prim)}}{I_{W(sec)}} \cdot \frac{k_B}{I_N} \cdot I_{m(sec)} \cdot 100\%$$

$I_{m(sec)}$	Measured value
$I_{s(a)}$	Restraint current display value on ESDR4T
$I_{w(prim)}$	Primary transformer rated current [A]
$I_{w\ (sec)}$	Secondary transformer rated current [A]
I_N	Rated current of the protection object (reference value)
k_B	Reference factor

The value calculated using this ratio must be the same for both the high and low-voltage sides. If the currents displayed are not of approximately the same magnitude, or if high differential currents are already displayed, the equipment should be shut down and the transformer assignment checked.

Testing with Cyclical Swapping

With the system off, the secondary connections of the CTs should be rotated between phases. Turn the system on and increase the excitation to gradually increase the load current. .

The resulting displayed values must be in accordance with the following:

$$I_{d(a)} = 2 \cdot \sqrt{3} \cdot I_{S(a)}$$

$$I_{s(a)} = \frac{1}{2} \cdot \left(\frac{I_{W(prim)}}{I_{W(sec)}} \cdot \frac{k_B}{I_N} \cdot I_{m(sec)} \cdot 100\%\right)$$

I $I_{s(a)}$	Restraint current display value
$I_{d(a)}$	Differential current indicated value
$I_{w(prim)}$	Primary transformer rated current [A]
$I_{w\ (sec)}$	Secondary transformer rated current [A]
I_N	Rated current of the protection object (reference value)
k_B	Reference factor
$I_{m(sec)}$	Measured value

During this test it is possible that the threshold value may be exceeded causing the relay to trip.

Attention

In the event of an extreme tripping, it must be ensured that the trip does not open the short-circuit bridge (in this case a tripping of the breaker would lead to large overvoltages).

If these current relationships are correct, the equipment can be shut down and the original condition restored..

Renewed Test with the Correct Connection

(Measurement of the maximum differential currents.)

Restart the unit after restoring the original connections. Test the differential current and the restraint current at 20 % of the rated current and compare these with the values measured from "Testing for Correct Connection". If the measurements match, you can slowly increase the current up to the rated current. The differential currents should be approximately zero until they reach the rated current. If this is not the case (e. g. with tapped transformers), the threshold value of the differential protection may have to be corrected to less sensitive values.

Determining the maximum differential currents during fault-free operation should give a starting point for working out the tripping characteristic (kick point).

- Start the short-circuited generator in de-energized condition
- Select the display of the differential currents by pressing the "Display" button (green "Differential current I_d" LED must light up)
- Next gradually increase the generator from a de-energized condition to 1.2 times the rated current and record the restraint currents and related differential currents
- Set the threshold values of the tripping characteristic

Appendix A.
Dimensions

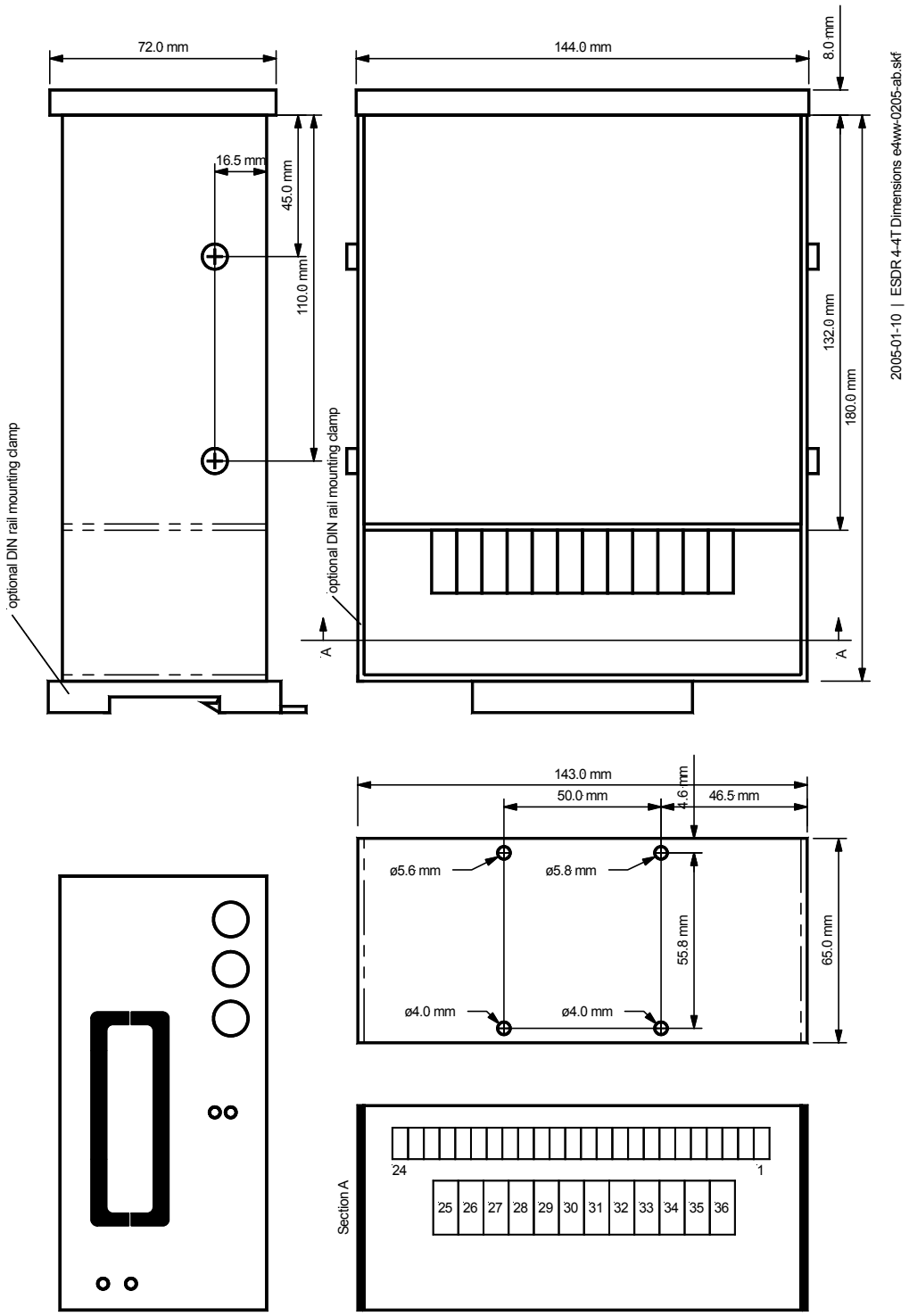


Figure 7-1: Dimensions

Appendix B.
Technical Data

Measurements, Currents ---------- isolated

- Measured currents (Nominal value I_N) ..... [1] ../1 A, or [5] ../5 A
- Measuring frequency ..... 40.0 to 70.0 Hz
- Accuracy ..... Class 1
- Linear measuring range ..... 5.0 × I_N
- Max. power consumption per path ..... < 0.15 VA
- Rated short time current (1 s) ..... [1] 100.0 × I_N, or [5] 30.0 × I_N

Ambient conditions ----------

- Voltage supply ..... 24 Vdc (+/-25 %)
- Intrinsic consumption ..... max. 6 W
- Ambient temperature Storage ..... -40 to 85 °C / -40 to 185 °F
  Operational ..... -20 to 70 °C / -4 to 158 °F
- Ambient humidity ..... 95 %, non-condensing
- Maximum altitude ..... 2000 m
- Degree of pollution 2

Digital inputs ---------- isolated

- Input range (VCont, digital input) ..... Nominal voltage 18 to 250 Vac/dc
- Input resistance ..... approx. 68 kΩ

Relay outputs ---------- isolated

- Contact material ..... AgCdO
- Resistive load (GP) ($V_{Cont, relay output}$)
  AC ..... 2.00 Aac@250 Vac
  DC ..... 2.00 Adc@24 Vdc, 0.36 Adc@125 Vdc, 0.18 Adc@250 Vdc
- Inductive load (PD) ($V_{Cont, relay output}$)
  AC B300
  DC 1.00 Adc@24 Vdc, 0.22 Adc@125 Vdc, 0.10 Adc@250 Vdc

Protective functions ----------

- Operating time ..... min. 100 ms
- Differential current ..... min. 10 %

Housing ----------

- Type ..... APRANORM DIN 43 700
- Dimensions (W × H × D) ..... 144 × 72 × 199 mm
- Front panel cutout (W × H) ..... 138 [+1.0] × 68 [+0.7] mm

- Terminals ..... Screw terminals depending on connector 2.5 mm² or 4.0 mm²
- Recommended tightening torque ..... [2.5 mm²] 0.5 Nm / [4.0 mm²] 0.6 Nm
  use 60/75 °C copper wire only
  use Class 1 wire only (or equivalent)
- Weight ..... Approx.. 1,000 g

Housing Protection ----------

- Protection system ..... IP42 from front with correct mounting
  IP54 from front with gasket (gasket: P/N 8923-1037)
  IP21 from rear
- Front folio ..... Insulating surface
- EMV-Test (CE) ..... tested according to applicable EN guidelines
- Listings ..... CE-Mark; UL-Listing for ordinary locations
- Type Listing ..... UL-/cUL-Listed, Ordinary Locations, File No.: E231544
- Marine Certification ..... GL

Appendix C.
List of Parameters

Unit number P/N _____ Rev _____

Version ESDR4 _____

Project _____

Serial number S/N _____ Date _____

Option	Parameter Line 1 - text - line 2	Setting range	Default setting	Customer settings	
	Sprache/LANGUAGE	Deutsch/English	English	☐ d ☐ e	☐ d ☐ e
	Software version				
	Coding (seal)	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	RELAY AND MESSAGES				
	Change relay- function?	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Funct. rel. 12	R/A	RR		
	Funct. rel. 34	R/A	RR		
	Auto-acknowledge relay	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Release delay Diff. curr.	0.10 to 99.98 s			
	Auto-acknowledge messages	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Acknowledge message aft.	1 to 99 s	1 s		
	Diff.current 1 relay outp.	0000	1..3		
	Diff current 2 relay outp.	0000	1..3		
	Range monit. Id relay outp.	0000	1..3		
	inrush deteced relay outp.	0000	1..3		
	BASIC SETTINGS				
	Nominal current	10 to 9,990 A	1,000 A		
	Curr. transf. Id high vol.	10 to 9,990 A	600 A		
	Curr. transf. Id low vol.	10 to 9,990 A	1,000 A		
	Nominal voltage high vol.	0,40 to 750.00 kV	10.00 kV		
	Nominal voltage low vol.	0.40 to 750.00 kV	6.30 kV		
	Vector group	see list *	Dd0		
	CONFIGURATION OF CONTROLLER				
	Differential Protection	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Release value Is/In	50 to 300 %	100 %		
	Diff. current 1 Id/In	0 to 300 %	20 %		
	Diff. current 1 Delay	0.02 to 99.98 s	0.10 s		
	Diff. current 2 Id/In	0 to 300 %	30 %		
	Diff. current 2 T1(Id<In)	0.02 to 99.98 s	0.04 s		
	Diff. current 2 T2(Id>In)	0.02 to 99.98 s	0.04 s		
	Diff. current Hysteresis	1 to 240 %	5 %		
	Stabilisation Rush	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Release value Rush	10 to 50 %	30 %		
	Stabilisation Overexcit	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Release value Overexcit	10 to 50 %	30 %		
	Rated frequency	50/60 Hz	50 Hz		
	Display harmonics	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off

* refer to vector group list on the next page

Vector Group List

Vector group	
Yd5	HV: ⅄-circuit arrangement, LV: Δ-circuit arrangement, 5 × 30 ° = 150 °
Yy0	HV: ⅄-circuit arrangement, LV: ⅄-circuit arrangement, 0 °
Dy5	HV: Δ-circuit arrangement, LV: ⅄-circuit arrangement, 5 × 30 ° = 150 °
Dd0	HV: Δ-circuit arrangement, LV: Δ-circuit arrangement, 0 °
Yz5	HV: ⅄-circuit arrangement, LV: Z-circuit arrangement, 5 × 30 ° = 150 °
Dz0	HV: Δ-circuit arrangement, LV: Z-circuit arrangement, 0 °
Yd11	HV: ⅄-circuit arrangement, LV: Δ-circuit arrangement, 11 × 30 ° = 330 °
Yy6	HV: ⅄-circuit arrangement, LV: ⅄-circuit arrangement, 6 × 30 ° = 180 °
Dy11	HV: Δ-circuit arrangement, LV: ⅄-circuit arrangement, 11 × 30 ° = 330 °
Dd6	HV: Δ-circuit arrangement, LV: Δ-circuit arrangement, 6 × 30 ° = 180 °
Yz11	HV: ⅄-circuit arrangement, LV: Z-circuit arrangement, 11 × 30 ° = 330 °
Dz6	HV: Δ-circuit arrangement, LV: Z-circuit arrangement, 6 × 30 ° = 180 °

Appendix A.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed. If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the unit(s), attach a tag with the following information:

- name and location where the control is installed
- name and phone number of contact person
- complete Woodward part numbers (P/N) and serial number (S/N)
- description of the problem
- instructions describing the desired repair

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors
- antistatic protective bags on all electronic modules
- packing materials that will not damage the surface of the unit
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material
- a packing carton with double walls
- a strong tape around the outside of the carton for increased strength

Return Authorization Number RAN

When returning equipment to Woodward, please telephone and ask for the Customer Service Department in Stuttgart [+49 (0) 711-789 54-0]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the unit(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at +49 (0) 711-789 54-0 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part numbers P/N (XXXX-XXX) that is on the enclosure nameplate
- the unit serial number S/N, which is also on the nameplate

How to Contact Woodward

Please contact following address if you have questions or if you want to send a product for repair:

Woodward GmbH
Handwerkstrasse 29
70565 Stuttgart - Germany

Phone: +49 (0) 711-789 54-0 (8:00 - 16:30 German time)
Fax: +49 (0) 711-789 54-100
E-mail: sales-stuttgart@woodward.com

For assistance outside Germany, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone number
USA	+1 (970) 482 5811
India	+91 (129) 409 7100
Brazil	+55 (19) 3708 4800
Japan	+81 (476) 93 4661
The Netherlands	+31 (23) 566 1111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical support
- Product training
- Field service during commissioning

Technical Support is available through our many worldwide locations, through our authorized distributors, or through GE Global Controls Services, depending on the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical engineering support, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference technical support.

Product Training is available on-site from several of our worldwide facilities, at your location, or from GE Global Controls Services, depending on the product. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***customer training***.

Field Service engineering on-site support is available, depending on the product and location, from our facility in Colorado, or from one of many worldwide Woodward offices or authorized distributors. Field engineers are experienced on both Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***field service***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Contact

Your company _____

Your name _____

Phone number _____

Fax number _____

Control (see name plate)

Unit no. and revision: P/N: _____ REV: _____

Unit type ESDR 4T _____

Serial number S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

Please be sure you have a list of all parameters available.

We appreciate your comments about the content of our publications.

Please send comments to: stgt-documentation@woodward.com

Please include the manual number from the front cover of this publication.

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Homepage

http://www.woodward.com/power

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address/phone/fax/e-mail information for all locations is available on our website (www.woodward.com).

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