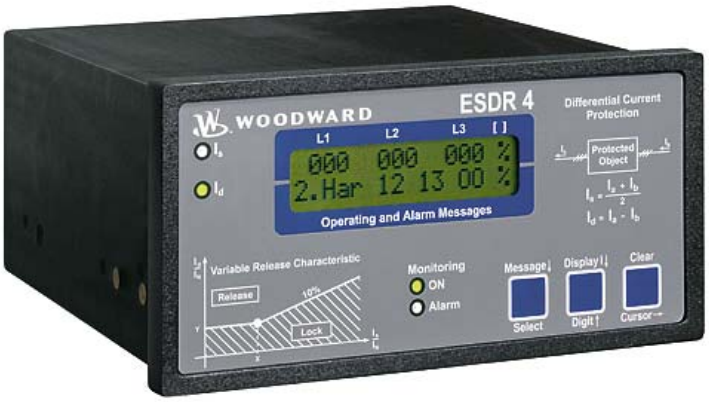
37137B

ESDR 4
Current Differential Protection Relay



Manual

Manual 37137B

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	04-04-13	Tr	Release
A	05-01-10	TP	Minor corrections
B	07-03-01	TP	Minor corrections

Contents

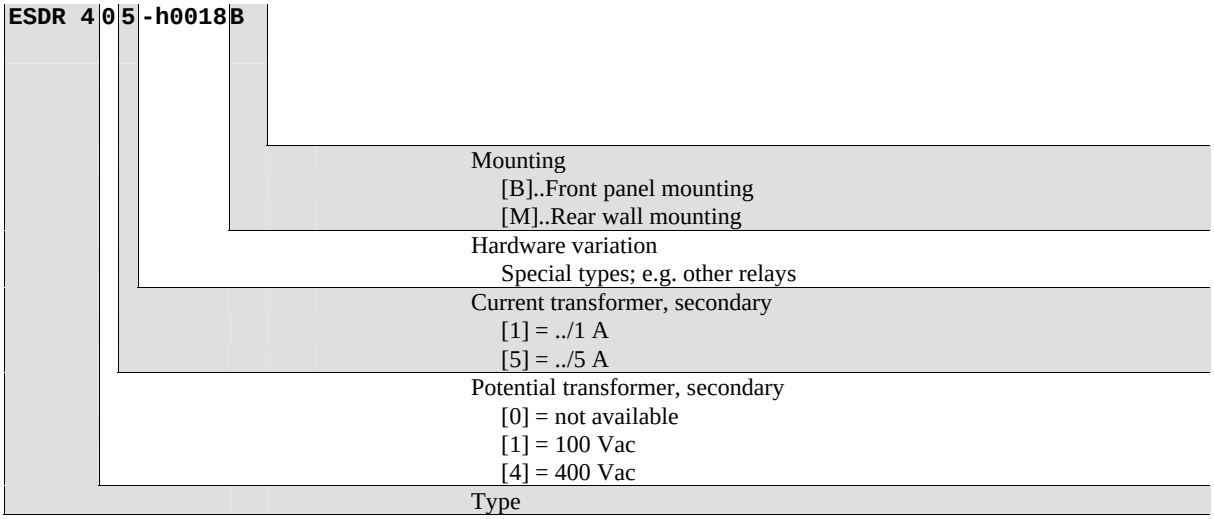
Figures and Tables

Figures

Chapter 1.
General Information

The ESDR 4 is a three-phase current differential protection relay for generators and motors (protected object). The currents flowing in the individual lines 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 4 as fault currents which initiate tripping.The unit does not trip if fault currents occur outside the protection zone. In this way, a selective protection is guaranteed.

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



Examples:
ESDR 401B (Standard unit, ../1 A CT input, for front panel mounting)
ESDR 405B (Standard unit, ../5 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

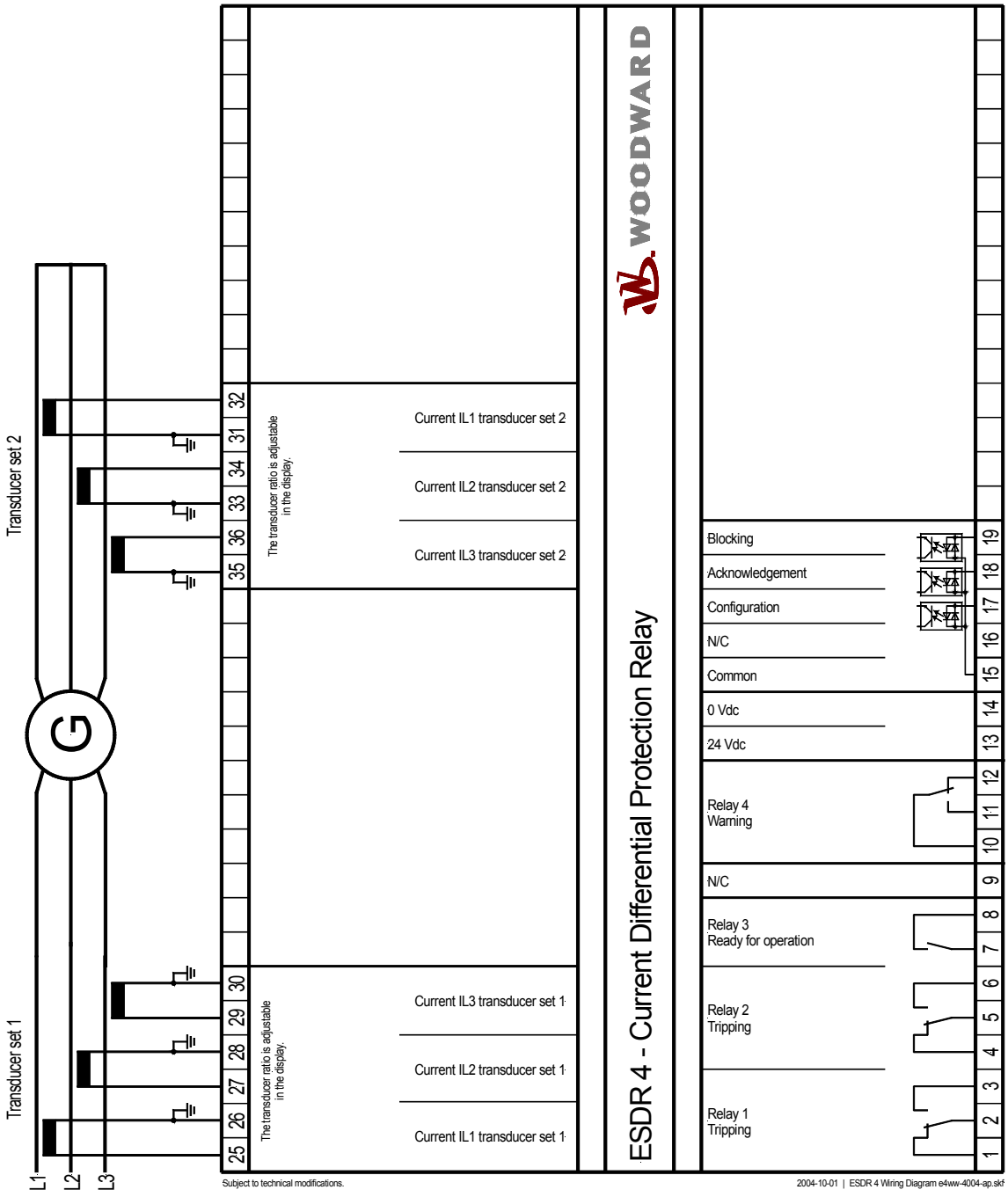


Figure 3-1: Wiring diagram

Power Supply

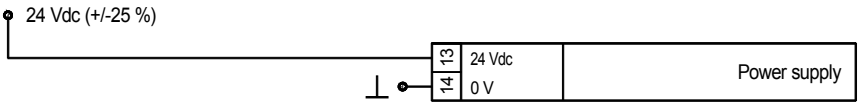


Figure 3-2: Power Supply

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.

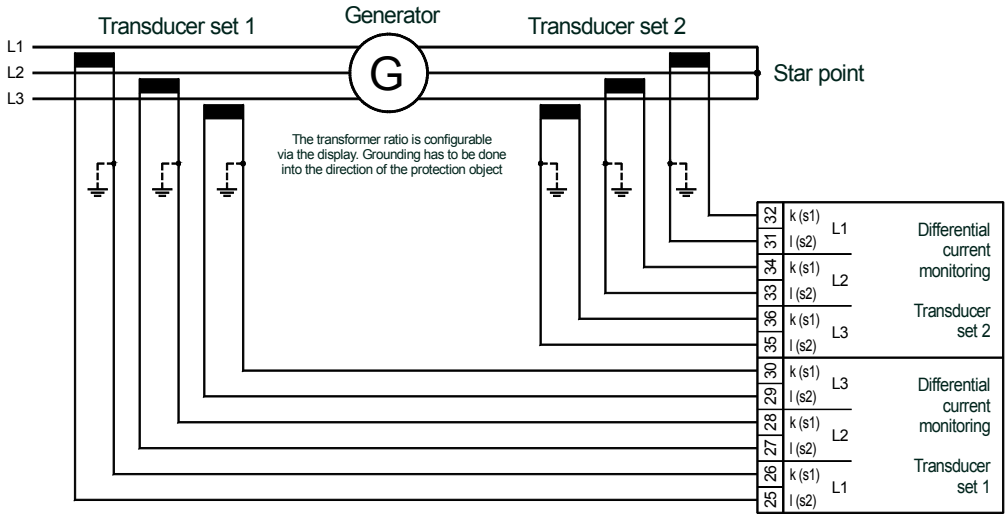


Figure 3-3: CT (transducer) inputs

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

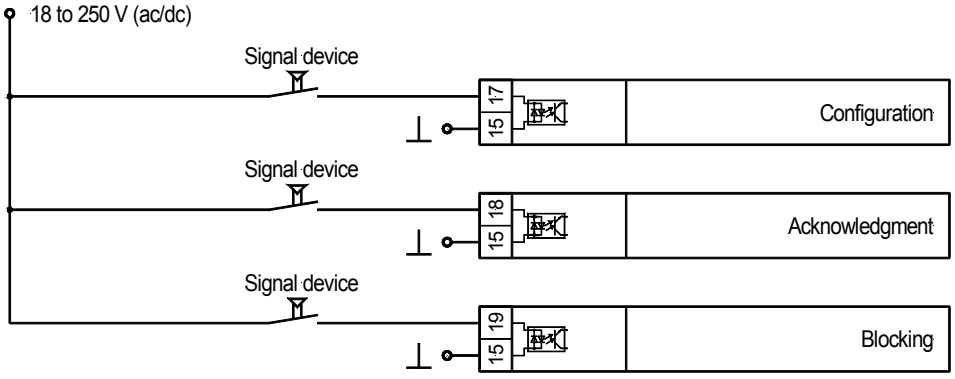


Figure 3-4: Discrete inputs

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

Relay Outputs

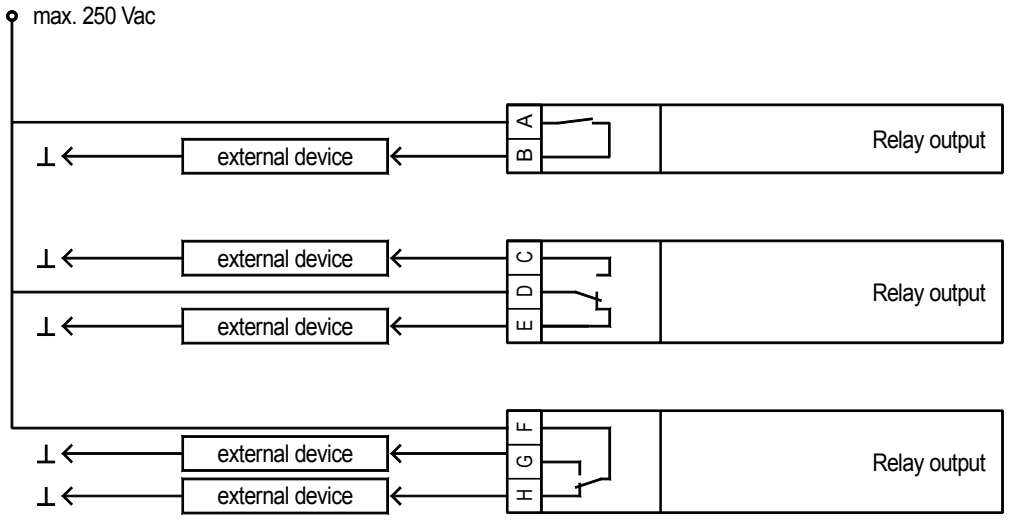


Figure 3-5: Relay outputs

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

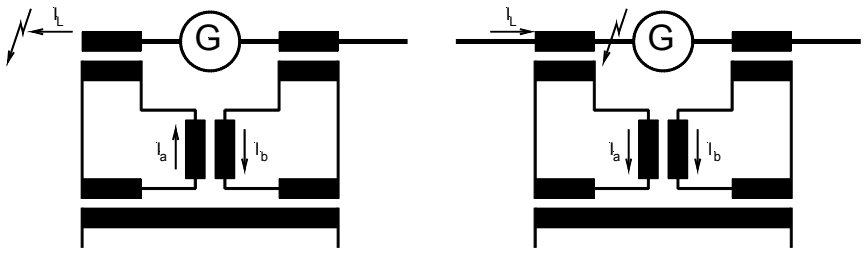
Introduction

The ESDR 4 is a three-phase current differential protection relay for generators and motors (protected object). The currents flowing in the individual lines 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 4 as fault currents which initiate tripping.The unit does not trip if fault currents occur outside the protection zone. In this way, a selective protection is guaranteed.

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.



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

Figure 4-1: Protection principle

Functional Description

Monitoring of the Differential Current

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

The first monitoring level 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% hysterisis relative to the generator rated current. .

The signal relay is only automatically reset if the function "automatic reset 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".

The two monitoring levels can also be used to change the characteristics of the control function (stage 1: small value and a long time; stage 2: high value and a short time)

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 positions of the corner points are determined by the coordinates P (X12/Y2) and P (X12/Y1). 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 monitioring levels for each restraint current I_s.

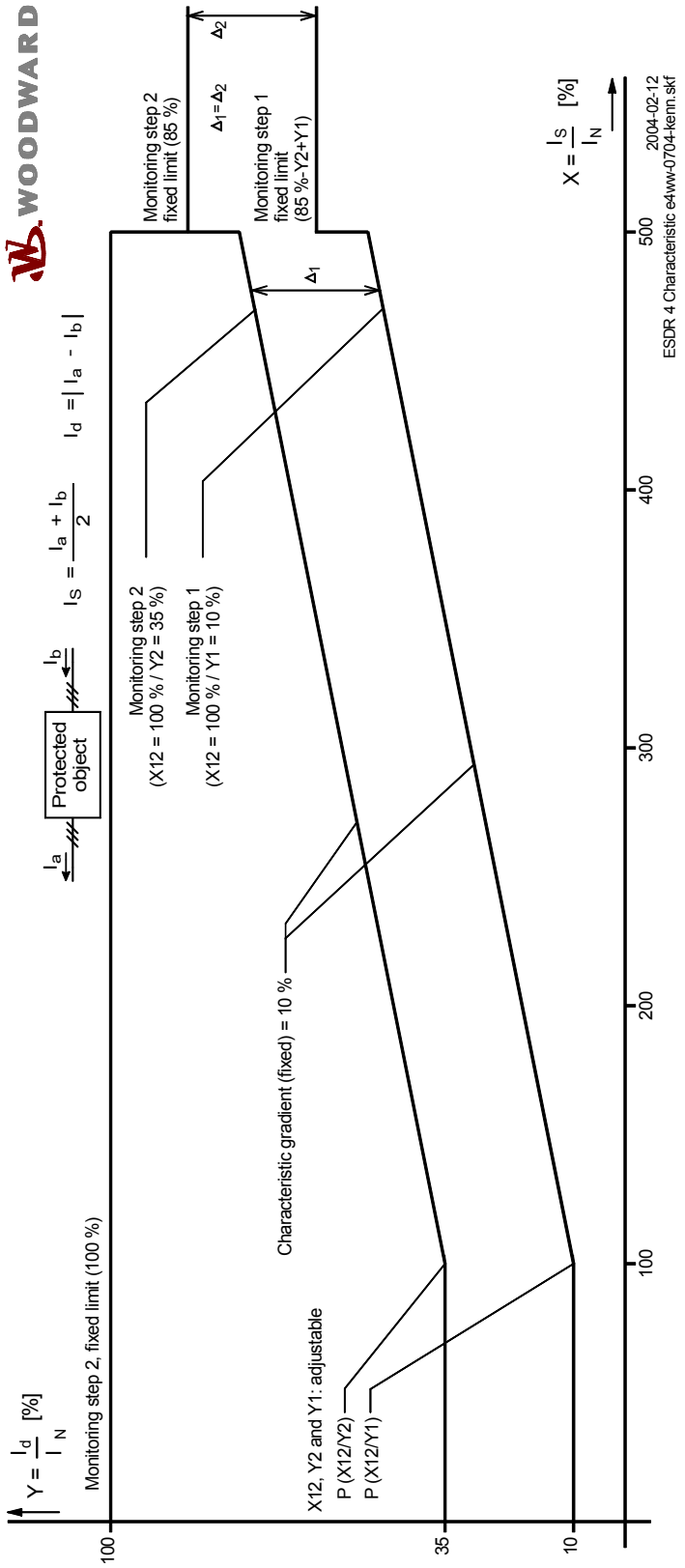


Figure 4-2: Characteristic

Control Inputs

Configuration
Terminal 17

When this input is energized, the unit locks into Configuration mode and stays in this mode until the 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, no relay can be enabled and no text is displayed.

Relays

Tripping (relay 1)
Terminals 1/2/3

This relay becomes enabled when the unit detects threshold limit 2 (main stage) has been exceeded. The configured differential current characteristics and delay time will determine how relay 1 functions.

Tripping (relay 2)
Terminals 4/5/6

This relay becomes enabled when the unit detects threshold limit 2 (main stage) has been exceeded. The configured differential current characteristics and delay time will determine how relay 2 functions.

Warning (relay 4)
Terminals 11/12/13

This relay becomes enabled when the unit detects threshold limit 1 has been exceeded. The configured differential current characteristics and delay time will determine how relay 4 functions.

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 set values for parameter "CT-ratio" or parameter "Generator Current" are outside the permissible limits (see page 19).
- the digital input "Blocking" is energized.
- the parameter "Monitoring" is configured to "Off".

Chapter 5.
Display and Operating Elements

The foil covering of the front panel consists of coated plastic. All keys comprise 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 indirectly illuminated (green). The contrast of the display can be continuously adjusted by means of a rotary potentiometer on the left hand side.

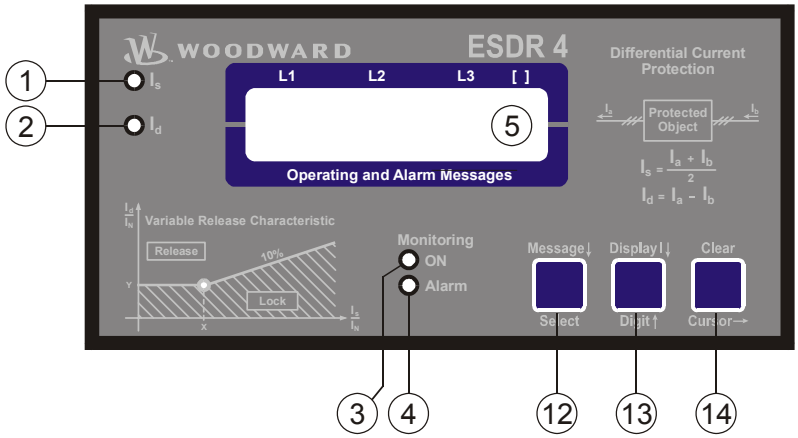


Figure 5-1: Front panel

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 till it is reset.

Buttons

The display can appear in two different modes: automatic mode or configuration mode. The change from one to the other is carried out by simultaneous pressing the " Display/Digit↑" and "Clear/Cursor→" buttons.

12 **Message↓ / Select**

Message↓ / Select

Automatic mode: Message↓ - Pressing this button scrolls the display of 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 proceeds to the next input screen. If the original value was changed by means of the "Digit↑" or "Cursor→" buttons, the new value is saved to the controller by pressing the "Select" button once. If this button is pressed again, the user causes the system to advance to the next parameter.

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

Automatic mode: Display V↓ -By pressing this button, the actual 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, number at the 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 →**

Automatic 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 Automatic mode, the measured values and alarms are displayed.

Top Line
displays I_s and I_d.

Bottom Line
Normal condition: blank
Otherwise: Alarm text.

Source	Alarm text
Differential current in Phase L1 exceeds the warning threshold (monitoring level 1)	Warning Id L1
Differential current in Phase L2 exceeds the warning threshold (monitoring level 1)	Warning Id L2
Differential current in Phase L3 exceeds the warning threshold (monitoring level 1)	Warning Id L3
Differential current in Phase L1 exceeds the tripping threshold (monitoring level2)	Fault Id L1
Differential current in Phase L2 exceeds the tripping threshold (monitoring level2)	Fault Id L2
Differential current in phase L3 exceeds the tripping threshold (monitoring level 2)	Fault Id L3
Non-permissible value of Parameter "CT-ratio" or "Generator Current"	Wrong Entry

These alarm texts are displayed sequentially by pressing the Message↓ button repeatedly. After the last alarm text has been displayed, the controller returns to the start 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. Should there be no entry, parameter change or other action for 60 seconds, the unit will automatically revert into Automatic mode.

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

Basic Data

```
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.

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

Language selection **english/german**

The screens can be displayed in German or English.

```
curr. transform.
ratio     0000/x
```

CT-Ratio Selection **10 to 6,000/{x} A**

The Ratio of the CTs being used is entered here. The CTs should be selected so that in fault-free operation at generator rated current, at least 60 % of nominal current flows in the CT-secondary. Failure to use properly a sized CT-Ratio leads to loss of resolution and inaccuracies in the monitoring functions.

```
generator nomin.
current    0000A
```

Generator rated current **5 to 6,000 A**

This value is used as reference value for the calculation and display of restraint current and differential current. The entered value of 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.

Example CT-Ratio 500/5 A
Range of Generator rated current 300 A to 500 A.

If the nominal value is less than 50% of the transformer ratio, the message "Wrong Entry" will be displayed on the screen in Automatic mode and the unit will deactivate monitoring functions (the Monitoring LED goes out).

```
automatic reset
relay       ON
```

Automatic reset of the relay **ON/OFF**

Applies only to monitoring level 2 (tripping).
Monitoring level 1 (warning) always Auto-resets.

ON .....The relays de-energize automatically when the fault is no longer present. The screen input "Automatic reset of error text" determines what happens to the Alarm-text in the display.
OFF .....The relays remain energized until they are reset.

Monitoring

```
monitoring
            ON
```

Monitoring **ON/OFF**

ON..... Monitoring of the differential current is active and the following screens of this option are displayed.

OFF..... The monitoring is de-activated and the following screens are not displayed.

```
release limit
Is/In     X=000%
```

Trigger Value I_S/I_N (X12) **50 to 300 %**

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

This value determines the horizontal position (X12-coordinates of points P [X12/Y1] and P [X2/Y2]) of the corner points of the Warning and Tripping characteristics.

```
release limit
Id/In     Y=000%
```

Limit value $I_d<I_N$ (Monitoring level 2, Y2) **5 to 40 %**

This value determines the vertical position (Y2-coordinate) of the corner point P [X12/Y2] of the tripping characteristic (monitoring level2).

```
pick-up t. Id>IN
release    0,00s
```

Relay enable delay time for $I_d>I_N$ (monitoring level 2) **0.04 to 3.00 s**

If the differential current surpasses the generator rated current without interruption over this time period, a fault condition for exceeding the threshold limit will be initiated.

```
pick-up t. Id<IN
release    0,00s
```

Relay enable delay time for $I_d<I_N$ (monitoring level 2) **0.04 to 3.00 s**

If the differential current surpasses the adjusted trigger threshold without interruption over this tme period, a fault condition for exceeding the threshold limit will be initiated.

```
release time
release    0,00s
```

Relay disable delay time (monitoring level 2) **0.10 to 3.00 s**

Only visible when the screen "Automatic reset of the relay" is configured to ON .

If the differential current value which initiated the fault condition should fall 2% or more below the trigger threshold limit and remain uninterrupted for the period of time configured here, the fault condition will be terminated and the relay output and the fault text will be reset.

```
automatic reset
error text   ON
```

Automatic reset of error text **ON/OFF**

Only visible when the screen "Automatic reset of the relay" is configured to ON

ON..... The displayed fault text will be automatically deleted, when the fault conditions are no longer detected.

OFF..... The displayed fault text must be deleted manually, and can only be done when fault conditions are no longer detected.

```
automatic reset
error text   00s
```

Delay for automatic reset of error text **1 to 60 s**

Only visible when the screens "Automatic reset of the relay" and **"Automatic reset of error text" are configured to ON**

The fault text will automatically delete, when the fault conditions are no longer detected for the time period set here.

```
warning
            ON
```

Warning (monitoring level 1) **ON/OFF**

ON .....The adjustable warning characteristic is being monitored and the following screens of this option are displayed.
OFF .....The adjustable warning characteristic is not being monitored and the following screens of this option are not displayed.

```
warning limit
Id/IN    Y=00,0%
```

Trigger value Id/IN (monitoring level1, Y1) **3.0 to 40.0 %**

Only visible when the screen "Warning" is configured to ON.

This value determines the vertical position of the corner point of the warning characteristic. The horizontal position (X12) is identical with that of the trip characteristic. Usually the warning limit is lower than the trip limit value.

```
pick-up time
warning    0,00s
```

Enable delay time of the "warning" relay (monitoring level1) **0.04 to 3.00 s**

Only visible when the screen "Warning" is configured to ON.

If the differential current exceeds the warning threshold curve without interruption over this time period, the control recognizes that the warning limit has been exceeded.

```
release time
warning    0,00s
```

Relay disable delay time (monitoring level 1) **0.10 to 3.00 s**

Only visible when the screen "Warning" is configured to ON

If the differential current value which initiated the warning should fall 2% or more below the trigger threshold limit and remain uninterrupted for the period of time configured here, the fault condition will be terminated and the relay output and fault text will be reset.

```
display value
Id           [-]
```

Display – measured value I_d in **[%] / [A]**

[%] .....The percentage of the rated generator current that is measured is displayed on the screen.
[A]: .....The measured absolute values are displayed on the screen.

```
display value
IS           [-]
```

Display – measured value I_S in **[%] / [A]**

[%] .....The percentage of the rated generator current that is measured is displayed on the screen.
[A]: .....The absolute measured values are displayed on the screen.

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 Automatic mode (press "Digit↑" and "Cursor→").

Commissioning using primary values
During commissioning, a configuration should be found which allows the finest possible adjustment of the currents. If the current is to flow through a short-circuiting bridge, the automatic voltage regulator should be turned off and the generator excitation adjusted manually.

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 about zero. The displayed restraint current should be checked using an external measuring device. Record all measured values.

If the displayed restraint currents are not approximately equal or very high differential currents are being displayed, then the system should be turned off and the configuration of the CTs should be 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:

$$I_s = \frac{1}{2} \cdot I_L$$

$$I_d = \sqrt{3} \cdot I_L$$

I_s Restraint current displayed value
I_d Differential current displayed value
I_L Line current (measured using a separate device)

During this test it is possible that the threshold value is 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 current: Read the differential current and the restraint current at 20% generator rated current and compare these with the original measured values. If the measurements agree, the generator current can be increased. The differential currents should remain close to zero right up till generator rated current is reached.

The determination of the maximum differential currents during fault-free operation should help in determining the corner points of the trip characteristic.

Appendix A.
Dimensions

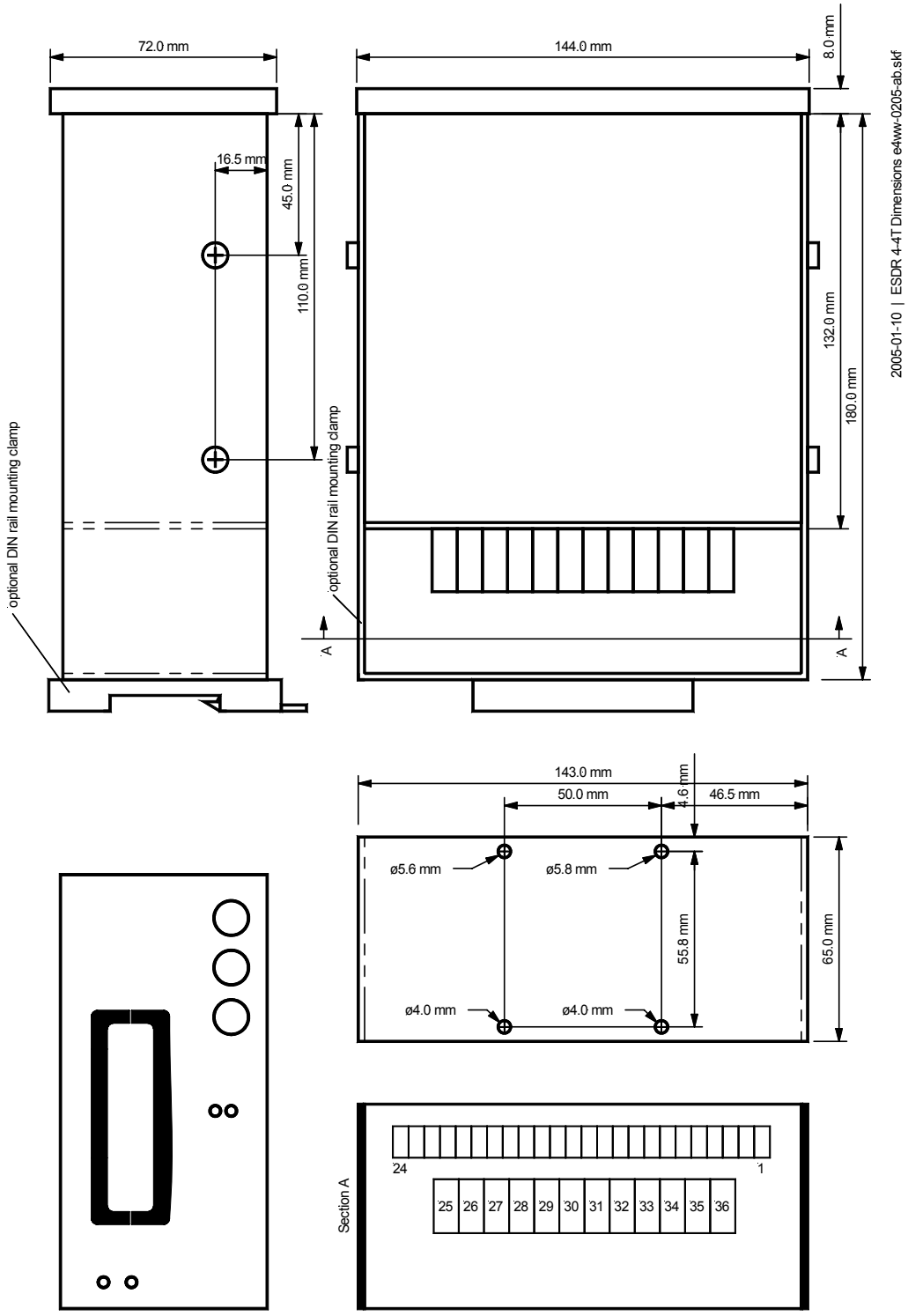


Figure 7-1: Dimensions

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 ($V_{Cont, digital input}$) ..... 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 screen ..... 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

Appendix C.
List of Parameters

Unit number P/N _____ Rev _____

Version ESDR4 _____

Project _____

Serial number S/N _____ Date _____

	Parameter	Setting Range	Default	Customer Settings	
BASIC DATA					
	SPRACHE/LANGUAGE	english/german	english		
	curr. transform. ratio	10 to 6,000/x A	500/x A		
	generator nomin. current	5 to 6,000 A	400 A		
	automatic reset relay	ON/OFF	OFF	☐ON ☐ OFF	☐ ON ☐ OFF
CONFIGURATION OF PROTECTION					
	monitoring	ON/ OFF	ON	☐ ON ☐OFF	☐ ON ☐ FF
	release limit IS/IN X=	50 to 300 %	100 %		
	release limit Id/IN Y=	5.0 to 40.0 %	40.0 %		
	pick-up t. Id>IN release	0.04 to 3.00 s	0.10 s		
	pick-up t. Id<IN release	0.04 to 3.00 s	0.10 s		
	release time release	0.1 to 3.00 s	0.10 s		
	automatic reset error text	ON/OFF	OFF	☐ ON ☐ OFF	☐ ON ☐OFF
	automatic reset error text	1 to 60 s	10 s		
	warning	ON/OFF	ON	☐ ON ☐OFF	☐ON ☐ OFF
	warning limit Id/IN Y=	3.0 to 40.0 %	30.0 %		
	pick-up time warning	0.04 to 3.00 s	0.10 s		
	release time warning	0.10 to 3.00 s	0.10 s		
	display value Id in	[%] / [A]	[%]	☐ % ☐ A	☐ % ☐ A
	display value Is in	[%] / [A]	[%]	☐ % ☐ A	☐ % ☐ A

Appendix D.
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 4_____

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.

Woodward GmbH
Handwerkstrasse 29 - 70565 Stuttgart - Germany
Phone +49 (0) 711-789 54-0 • Fax +49 (0) 711-789 54-100
sales-stuttgart@woodward.com

Homepage

http://www.woodward.com/power

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

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