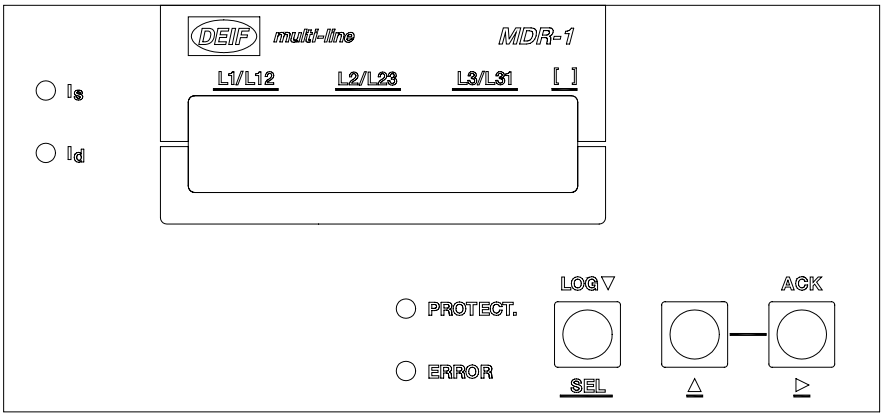
User's manual

Multi differential relay Type MDR-1

multi-line

4189340016D



- *3-phase AC measurements*
- *Dynamic compensation for external failures*
- *2-stage warning / trip*
- *Fast reaction time (40 ms)*

CE

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1. Warnings, legal information and notes to CE-marking

This manual gives general guidelines on how to install and operate the product MDR-1. Installing and operating MDR-1 implies work with dangerous current and voltages, and therefore this should only be done by qualified personnel. DEIF takes no responsibility for operation or installation. If there is any doubt about how to install or operate the system on which MDR-1 measures, the company responsible for installation or operation must be contacted.

MDR-1 is CE-marked with respect to the EMC directive for residential, commercial and light industry plus industrial environment. This covers all environment types where MDR-1 normally can be used.

MDR-1 is CE-marked with respect to the low-voltage directive for up to 300 V phase to ground voltage, Installation category (Overvoltage category) III and pollution degree 2. 300 V phase to ground voltage corresponds to 480 V phase to phase voltage in 4-wire networks and 500 V phase to phase voltage in 3-wire networks.

2. Application

The MDR-1 differential relay is a microprocessor-based control unit that monitors the differential currents for a synchronous generator or synchronous /asynchronous motor (object).

The MDR-1 measures via current transformers each phase current on both sides of the object. The current transformers are setting the borders for the protection area. Any failure within the borders (2- or 3-phase short circuits, earth leaks) will be detected as errors (Id: differential currents, current flowing throug the 2 current transformers of the phase in question differs) and, if limit is exceeded, cause a warning or a trip.

If errors should occur outside the borders, the MDR-1 will **not** trip, as the above-mentioned phase currrents are equal to each other. In this manner, selective tripping is achieved.

Excluding external measuring transformers it contains all necessary measuring circuits and presents all values on a LCD display. Values and messages are presented in clear text and all measuring values are presented in engineering units.

The MDR-1 is flexible and menu-programmed, enabling the user to match the unit to the object in question. Programming is password protected.

The MDR-1 executes a cyclical self-test, with error messages if any occurs.

2.1 Standard functions

The unit is designed for differential current control of a 3-phase generator/motor.

Inputs: - 6 currents via. current transformers
- 4 binary control inputs

Outputs: - 4 relay outputs (sys. OK, warning, 2-stage trip)

2.2 Generator protective function

Differential current (3-phase) protection, with programmable dynamic compensation (trip curve).

- Warning: Programmable value and delay
- 2- stage differential current trip:

    1) Fixed: Id >100% of nominal generator current, programmable delay
    2) Programmable value, programmable delay

2.3 Display of values and texts

LED indicators

Stabilising current, Is (green)	in AUTO mode	The display is showing values for the actual phase currents.
Differential current Id (green)	in AUTO mode	The display is showing values for differential currents.
MON (green)	in AUTO mode	Monitoring and protection is active
ALARM (red)	in AUTO mode	Limit value for step 2 (breaker trip) is reached. Stays ON until acknowledge.

LC-Display

Upper line	in AUTO mode	Selectable display of 3 phase currents or 3 differential currents
Lower line	in AUTO mode	Status- and alarm messages
Upper and lower line	in PARAM mode	Parameter setting of all parameters in clear text.

2.4 Acknowledge of alarms

- auto ack. yes/no programmable
- remote ack. via pushbutton input
- front pushbutton "Ack."

3. Description

3.1 General

The MDR-1 measures 6 currents and calculates for each phase the average (Stabilising current, Is) and the difference (differential current, Id). These calculated currents can be displayed either in engineering units (amps.) or as a percentage of the nominal current (In).

3.2 Self-check

For self-check purposes, the unit is supplied with a relay output "Sys OK". The relay opens if:

- supply voltage sinks below 19 VDC.
- internal failure occurs
- faulty keyed-in values for current transformers compared to generator nominal current.

3.3 Differential current Warning/trip

2 Steps:

First step can e.g. be used as a warning. By value above the user-definable trip curve, a text warning will appear on the LC display, and a relay will operate. The operating and reset after normal delays are user-definable. If the differential current drops below the warning curve, the display message will disappear and the output relay will return to normal.

The first step can be enabled/disabled by the user.

The step 2 is intended for a trip function. This step differs from warning by giving the feature of free configuration of a differential current trip curve and, as an addition, a fixed trip placed on 100% nominal current. For each trip function, the trip- and reset after normal delays are user-definable.

It is hereby possible to have a shorter trip delay at rising differential currents.

If one or both trip limits are exceeded, a text will appear in the display, and 2 separate trip relays will be activated. One relay can be used for breaker trip, the other for messages e.g. to an upper alarm system. Automatic reset of relays and/or display texts can be chosen.

The hysteresis is in both steps factory-set to a fixed value of 2% referring to the nominal current.

4. Parameter setting

All necessary data can be keyed-in in clear text. To do this, the MDR-1 must be in parameter mode.

NOTE: The protective functions are active during parameter setting. As a consequence of this, keying-in of faulty data may result in an unwanted trip.

4.1 Select parameter menu

By pushing the buttons "A" and "ACK" simultaneously a swap between mode "auto" and "parameter" can be carried out. Pushbutton functions are changed to the indications below the pushbuttons: "LOG" function to "P", "A" function to "▲" and "ACK" to "▶" (see later).

Also, parameter mode can be selected with the input on terminal 17, "Parameter mode". See paragraph 4.0 Terminal list. The MDR-1 will stay in parameter mode as long as the input is activated.

In parameter mode, all setpoints and timers can be changed.

If no parameter setting inputs has taken place for 2 minutes, the MDR-1 will automatically return to "auto" mode.

To make key-in of values easier, the function is equipped with a "sweep" function. By holding a button down, a fast sweep through values can be carried out.

"P" pushbutton

Stores the keyed in display parameter value, jump to the next parameter.

If the display value has been changed via the "▲" or "▶" buttons, the new value can be stored by pushing the "**P**" button once. If the button is pushed twice, the display will jump to the next parameter.

"▲" pushbutton

Steps the displayed value up one unit (within allowed limits).

"▶" pushbutton

Analog values: Moves the cursor to the next digit
Binary values: Swap of different functions (e.g.: ON/OFF)

If "**P**", "▲" and "▶" are pressed simultaneously, the MDR-1 will return to factory settings.

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4.2 Language

Display	Factory set	Commissioning value	Description
Sprache/Language English	German		Can be set to English or German

4.3 Current transformers

Display	Factory set	Commissioning value	Description
Current transformer Ratio 0500/1	500/5		10/.. to 6000/.., ../1 or ../5. Current transformer settings in amps.

4.4 Generator nominal current

Display	Factory set	Commissioning value	Description
Generator nominal Current 0400 A	400		5 A to 6000 A Generator nominal current (100%)

4.5 Automatic reset

Display	Factory set	Commissioning value	Description
Automatic reset relay ON	OFF		ON/OFF. ON: After warning/trip and return to normal diff. current, the relays will return to normal automatically. OFF: After warning/trip and return to normal diff. current, the relays will NOT return to normal before "Ack." button or input is activated.

4.6 Setting of trip curve

A trip curve is shown on fig.1. The curves represents the warning and trip values (Y = differential current Id divided by generator nominal current In) referring to the current relation (X = stabilisation current (Is) divided by In). The stabilisation current (Is) is defined as the average value of the two measured currents (inner and outer current).

The starting horizontal limit lines are placed according to the keyed-in values of the points P(X, Y1) and P(X, Y2). These can be positioned anywhere within the marked area, and must be decided according to the specifications of the plant in question.

For warning- and trip lines, the following area is present:

Id/In	> 100%	Fixed trip point (trip 1), not dependent on stabilisation current.
Is/In	0...X	The trip (trip 2) is not dependent on stabilisation current.
Is/In	X...5*In	The trip (trip 2) is dependent on the stabilisation current. A 100% change of stabilisation current will result in a move of trip curve equal to 10%.
Is/In	>5*In	the trip (trip 3, replaces trip 1 and 2) point is constant (85%).

For the pre-warning and the trip, different curves may be entered. The trip X-value defines the horizontal position (X-value) for both steps. The vertical position (Y-value) can, however, be chosen separately for pre-warning / trip, i.e. at any stabilisation current, a fixed difference between the two steps will always be present.

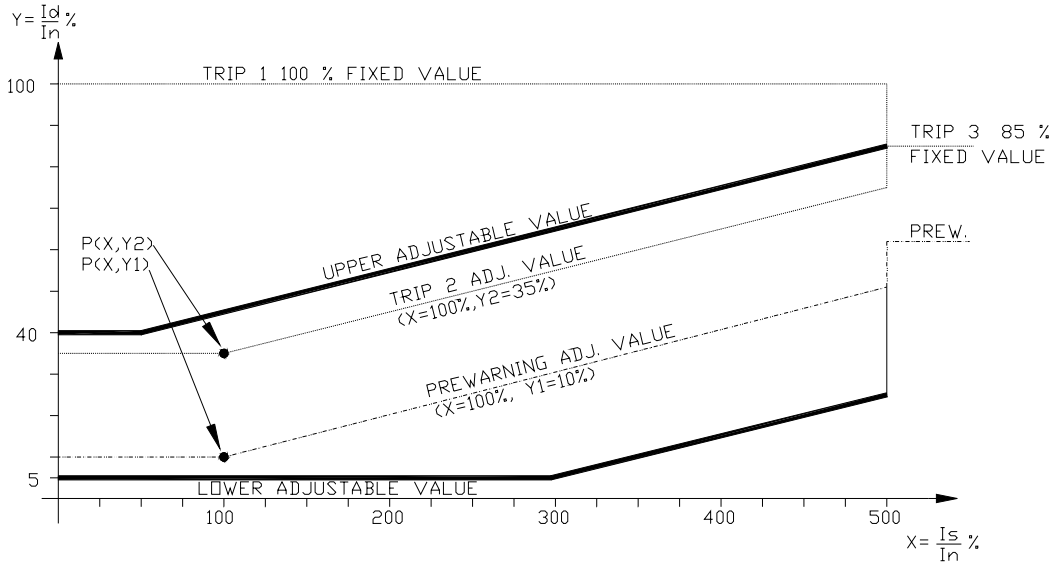

Fig. 1 Trip curve

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Display	Factory set	Commissioning value	Description
Monitoring ON	ON		ON/OFF. Monitoring. ON: monitoring is active. OFF: monitoring is inactive, but prewarning can still be set active.
Release limit IS/IN X=100%	100%		50%...100%. Definition for warning and trip (trip 2) curves. Trip relation between stabilisation current Is and nominal current In. This parameter defines the horizontal break point X (see fig. 1).
Release limit Id/IN Y=05.0%	40.0%		5.0%...40.0%. Vertical trip (trip 2) point value (Y2) for relation between differential current Id and stabilisation current Is. (see fig. 1).
pick-up t. Id>IN release 0.10s	0.10s		0.04...3.00 s. Trip (trip 1) delay if Id/In >100%.
pick-up t. Id<IN release 0.10s	0.10s		0.04...3.00 s. Trip (trip 2) delay if Id/In < 100% (keyed-in trip curve).

4.7 Automatic reset settings

Display	Factory set	Commissioning value	Description
Release time Release 0.10s	0.10s		*This parameter is only active if "Automatic reset relays" is ON.* 0.10...3.00s. Delay after return to normal, before trip relays (step 2) returns to normal position.
Automatic reset error text ON	ON		*This parameter is only active if "Automatic reset relays*" is ON. ON/OFF. ON: After warning/trip and return to normal diff. Current, the display will return to normal automatically. OFF: After trip and return to normal diff. current, the relays/display will NOT return to normal before "Ack." button or input is activated.
Automatic reset error text 10s	10s		*This parameter is only active if "Automatic reset* error text" is ON. 1...60 s. Delay after return to normal, before display text returns to normal.

4.8 Setting of pre-warning

Display	Factory set	Commissioning value	Description
Warning ON	ON		ON/OFF. Pre-warning. ON: Prewarning is active. If Id/In value exceeds preset value, pre-warning will be released. OFF: Pre-warning is inactive.
Warning limit Id/IN: Y=25.0%	30.0%		*This function is only active, if PRE-WARNING = ON.* 5.0...40 %. Vertical pre-warning point value (Y1) for relation between differential current Id and stabilisation current Is. (see fig. 1).
pick-up time warning 0.10s	0.10s		*This function is only active, if PRE-WARNING = ON.* 0.04...3.0 s. Pre-warning (step 1) delay.
Release time Warning 0.10s	0,10s		*This function is only active, if PRE-WARNING = ON.* 0.10...3.0 s. Delay before pre-warning relay and text returns to normal. Measured value has to drop value 2% below preset value before timer is started.

4.9 Setting of Display

Display	Factory set	Commissioning value	Description
Display value Id (%)	(%)		(%) / A. Display of measured differential current (in AUTO mode). (%) displays value in % of keyed-in nominal generator current. "A" displays value in actual value.
Display value IS (%)	(%)		%) / A. Display of measured stabilisation current (in AUTO mode). (%) displays value in % of keyed-in nominal generator current. "A" displays value in actual value.

Terminal list

In the following, these terminologies will be used CC = Closed contact
OC = Open contact

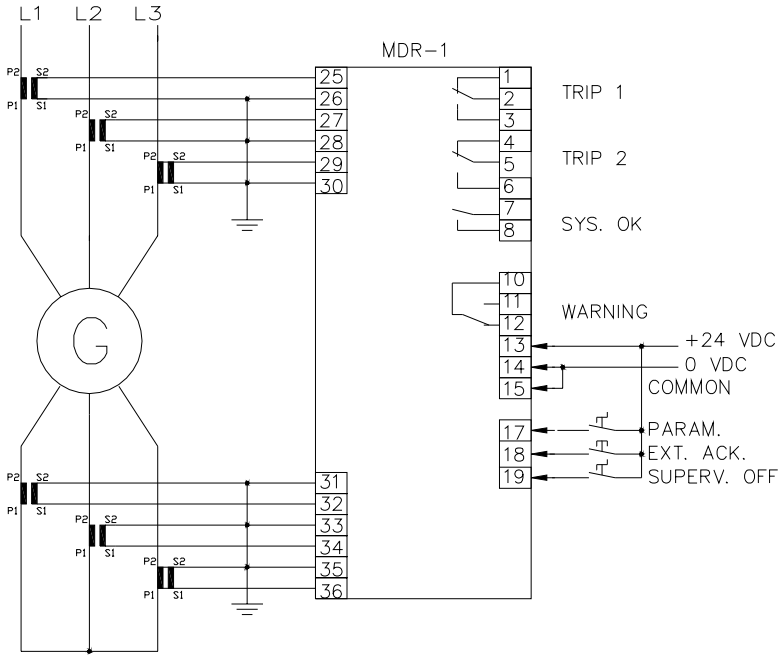
If galvanic separation of 24 VDC supply and binary inputs are required, the "common" terminal 15 can be connected on a second power source 0 (or neutral at 220 VAC signal voltage). If the same 24 VDC is used for both power supply and signal supply, connect the "common" terminals 15 to terminal 14.

All binary inputs are considered ON (CC) if the voltage is above 18 V DC/AC.

Terminal no.	In/Out	I/O Type	Signal name	Description
1 2 3	Out	Relay	Trip relay 1	Trip: Term. 1-2 : OC Term. 2-3 : CC
4 5 6	Out	Relay	Trip relay 2	Trip: Term. 4-5 : OC Term. 5-6 : CC
7 8	Out	Relay	Supervision	Supervision ON = CC
10 11 12	Out	Relay	Warning	Diff. current warn. : Term. 10-11: CC Term. 10-12: OC
13 14	+ 24V -		24 VDC power supply	24 VDC +30/-20 %
15	Com.	Common		Common 0 for input terminals 16, 17, 18 and 19
16	In	Binary	Spare	
17	In	Binary	Parameter set	Go to parameter setting mode : U (17-15)>18 V
18	In	Binary	Acknowledge	Acknowledge alarm: U (18-15)>18 V Delay: 3 sec.
19	In	Binary	Supervision OFF	Supervision OFF: U (19-15)>18 V If not used: Connect to term. 15.
25 26	In s2 s1	AC I	I L1 outer	Signal from current transformer .../1 or .../5.
27 28	In s2 s1	AC I	I L2 outer	Signal from current transformer .../1 or .../5.
29 30	In s2 s1	AC I	I L3 outer	Signal from current transformer .../1 or .../5.
31 32	In s2 s1	AC I	I L1 inner	Signal from current transformer .../1 or .../5.

33 34	In s2 s1	AC I	I L2 inner	Signal from current transformer .../1 or .../5.
35 36	In s2 s1	AC I	I L3 inner	Signal from current transformer .../1 or .../5.

5. Wiring diagram



6. Commissioning

This paragraph gives general guidelines on how to set up the product MDR-1. Installing and operating MDR-1 implies working with dangerous current and voltages, and therefore this should only be done by qualified personnel. DEIF takes no responsibility for operation or installation of MDR-1. If there is any doubt about how to install or operate the system on which MDR-1 measures the company responsible for installation or operation must be contacted.

Before commissioning, check phases for correct voltage and correct rotary field.

Warning: Missing or incorrect voltage and other input fails may lead to malfunction and damage to the unit.

For further explanations regarding setting the different parameters and their functions, we refer to paragraph 4 "parameter setting"

Connect the MDR-1 according to paragraph 5.

6.1 Pre-adjustment

- Connect 24 VDC. The green LED "Superv. ON" must be lit.
- Activate "Parameter mode". (Push "digit ▲" and "cursor ▶" button simultaneously, or set input on terminal 17 "ON").
- Choose input display "curr. transform. ratio". (Use button "select" to step through displays) and set the current transformer primary and secondary values.
- Choose input display "generator nomin. current". Set the correct generator nominal current.
- Activate "auto" mode. (Push "digit ▲" and "cursor ▶" button simultaneously, or set input on terminal 17 "OFF").

6.2 Check of current inputs

WARNING: **CHECK WITH GENERATOR SUPPLIER BEFORE CARRYING OUT THE FOLLOWING TEST PROCEDURE. THE PROCEDURE IS DEPENDENT ON THE AVR CAPABILITY TO BE ADJUSTED TO ZERO VOLTAGE. IF IN ANY DOUBT, DO NOT USE THIS PROCEDURE. DEIF A/S CARRIES NO RESPONSIBILITY FOR DAMAGES OR ACCIDENTS OCCURRED DURING TESTING.**

- Short-circuit generator, and start with Automatic Voltage Regulator (AVR) set to zero.
- Bring current up to approx. 2 x nominal current by bringing up the generator voltage.
- Check the 2 running currents (inner and outer) for each phase with an external ammeter.
- The display value Is (stabilisation current) is the average of the inner and outer current.
- The display value Id (differential current) is the inner and outer current subtracted.
- If differential currents occur, that cannot be repeated with the external ammeter measurements, the current measurement circuits are to be checked.

6.3 Setting of max. differential current during normal running conditions

This is a determination of the break point position of the limit curves (warning and trip).

- Short-circuit generator, and start **without** Automatic Voltage Regulator (AVR).
- Push "display" button for read-out of measured differential current (Id) (Green LED "Id" must be lit).
- Raise generator current step-by-step from zero to 1.2 x nominal generator current. Write down generator stabilisation currents and differential currents for each step.
- The setting of the warning break point is to be done in such a manner, that the differential current warning appears at Id = 30% of the generator nominal current.
- The setting of the trip break point is to be done in such a manner, that the differential current trip appears at Id = 40% of the generator nominal current.

6.4 Check of warning and trip points

Phase L1:

- Stop the generator and short circuit the secondary side of current transformer "outer". Disconnect terminals 31 and 32.
- Short-circuit generator, and start **without** Automatic Voltage Regulator (AVR).
- Raise generator current slowly. The differential current warning must appear at Id = 30% of the generator nominal current. The differential current trip must appear at Id = 40% of the generator nominal current.
- Stop the generator. Acknowledge alarms with pushbutton "Ack.".
- Reconnect terminals 31 and 32, remove short-circuit on current transformer.

Phase L2 and L3: Repeat the procedure described for phase L1.

7. Order information

MDR-1-x

Basic unit, 24 VDC aux. supply

Current transformer ../5 A:	Replace "x" with 5
Current transformer ../1 A:	Replace "x" with 1
EXAMPLE:	MDR-1-1 (MDR-1, current transformer ../1 A)

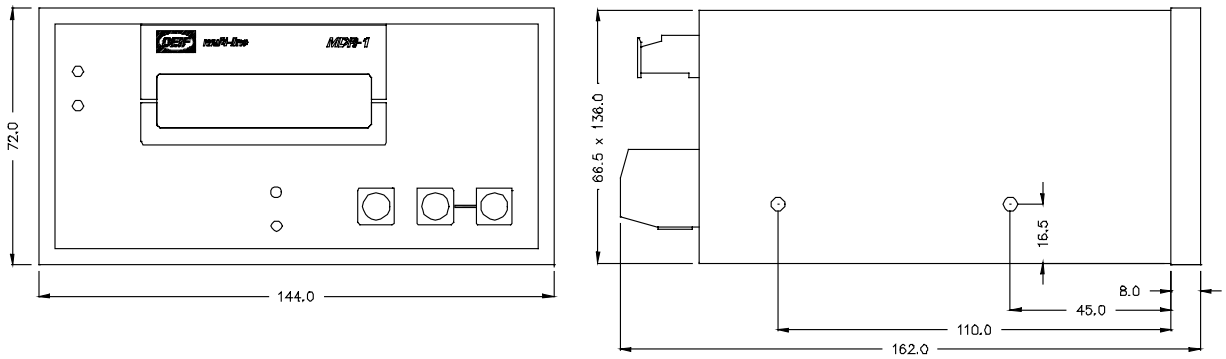
8. Technical data

Accuracy:	1% of generator nominal current
Operating temp:	-20...+70 ^{o}C (LCD display limited to -20...+60 ^{o}C
Climate:	Class HSE, to DIN 40040
Measuring current:	../1 or ../5 A, consumption max. 0.1 VA per phase.
Max. overcurrent:	5 x $I_{nom.}$ Continuous 30 x $I_{nom.}$ max. 100 ms 100 x $I_{nom.}$ max. 10 ms
Measuring frequency:	40 Hz...70 Hz
Aux. supply:	24 VDC +30/-25 % max. 6 VA
Binary inputs:	input ON at voltage 18...250 VDC or VAC input impedance 68 k

Relay outputs:	Contact rating 8 A @250 VAC max. Voltage 380 VAC lifetime min. 100.000 changeovers
Safety:	To EN 61010-1 Installation category (Overvoltage category) III, 300V. Pollution degree 2.
Galvanic separation:	Between binary inputs and remaining circuits Between current inputs and between current inputs and remaining circuits Between relay outputs and between relay outputs and remaining circuits.
EMC:	To EN 50081-1/2, EN 50082-1/2
Housing:	DIN 43700, WxHxD: 144x72x162 cutout 138x67 mm
Connections	Max. 2.5 mm^2.
Protection:	IP 21, however, front IP 54
Weight:	Approx. 1.0 kg

9. Dimensions

All dimensions in mm



Errors and changes excepted