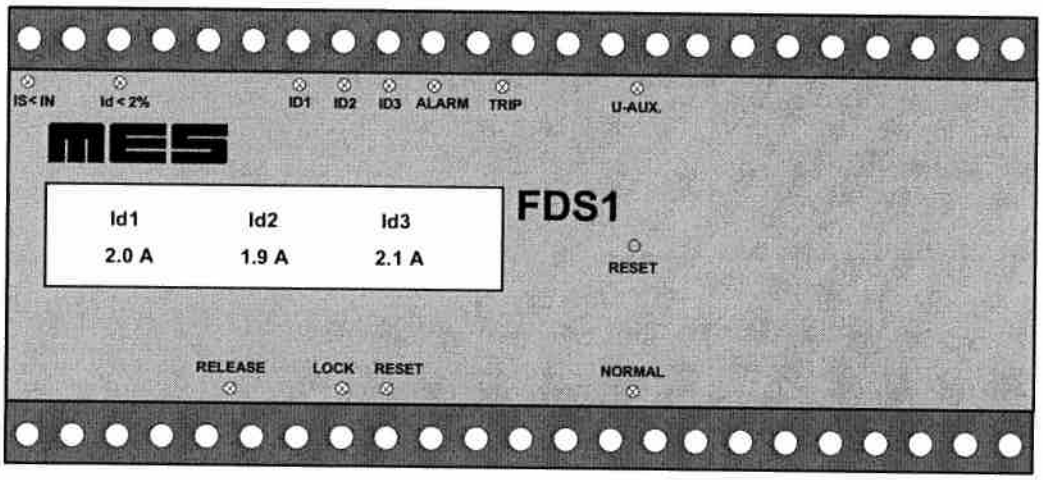
MULTIFUNKTIONALE ENERGIE SYSTEME

Differential Protection Device for Generators FDS1

Version09 31.10.2007 / Prog. Vers. >= 1.14



View 1

FEATURES

- LCD-indication of phase currents and differential currents
- LCD-indication of phase currents in %
- LCD-indication of differential currents
- LCD-indication of differential currents in %
- LCD-indication illuminated
- Setting can be classified
- LED-indication of operation- and fault signals
- 3 fault signal outputs
- 2 analogue outputs
- Displaytext german/english
- Useable in 1A or 5A current transformer circuits

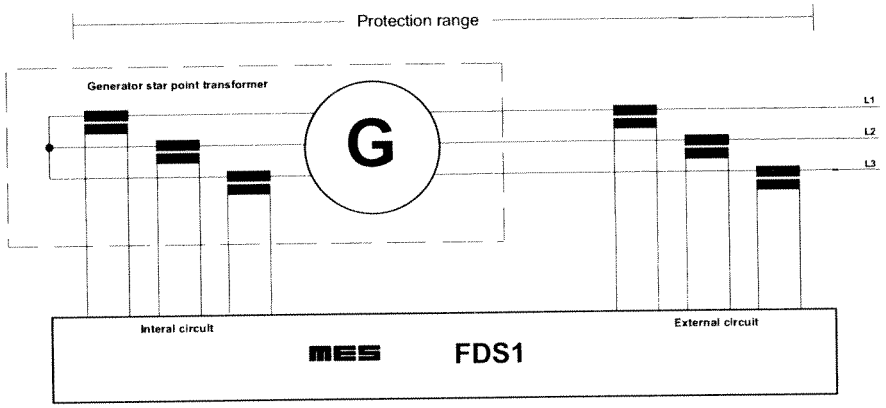
1.0 SCOPE OF APPLICATION

The differential protection device FDS1 has to be applied for protection of three-phase generators or three-phase synchronous- or asynchronous motors. It detects the differential currents within the protective range (view 2) and will trip in case of reaching of the pre-set limit values.

By ordering the FDS1 it is necessary to give up detailed information about the transformer current (... / 1A , ... / 5A).

2.0 METHOD OF OPERATION

The differential protection measurement is the current comparison between generator star point and the generator output or incoming into a switchboard. The summation of all currents must be zero.



View 2: Measurement principle

Three current transformer circuits measure the current in the generator star point (internal circuit), three additional current transformer circuits are to be arranged on consumer side and measure the consumer current (external circuit). Measurement in this six current paths take place as a simultaneous scanning of all six measuring circuits with 16 scans per cycle and path. For each current value the real RMS value is calculated and evaluated after running-out of one cycle. The minimum response delay is approximately 130 ms.

Via the relay output A1 a pre-warning (Para. B1) may be emitted. The relay output A2 emits the disconnecting command to the generator circuit breaker (Para. A4). In order to avoid faulty tripping, e.g. at starting up of big electric drives, the response action may be delayed for an adjustable period. Reset after pre-warning or tripping takes place manually by pressing the RESET-button (view1). Reset may be also carried out automatically after an adjustable period or via an external input (Para. B5 or B6).

Two analogue outputs can be used. Analogue output 1 0(2) – 10 V (Para. B10 - 13) or analogue output 2 0(4) - 20 mA (Para. B14 - 17).

The FDS1 is working with a nominal frequency, pre-set by classifying. Nominal frequencies of 50 Hz or 60 Hz are adjustable (Para. A6).

For measurement and disconnection following values are applied:

— nominal current pre-set nominal current of the generator

— stable current $Is = (I_{Intern} + I_{Extern})/2 \quad [A]$

$Is = ((I_{Intern} + I_{Extern})/2)/I_{Nenn} x100 \quad [\%]$

— differential current $Id = I_{Intern} - I_{Extern} \quad [A]$

$Is = (I_{Intern} - I_{Extern})/I_{Nenn} x100 \quad [\%]$

The difference between internal and external current will be calculated by the currently values. Therefore it is additionally possible to realise and evaluate a phase failure.

3.0 FUNCTION

3.1 Commissioning

The FDS1 has to be connected according to the terminal allocation (view 3).

After connection of the auxiliary voltage the LED „U-AUX." lights and measuring starts. The actual measuring values are indicated on the display (view 1 and Para. B9).

3.2.0 Classifying

For correct adaptation to the respective case of application, classifying is required. The response values must be checked and adapted to the installation if necessary. The set ranges and response values can be taken out of the table under point 6.

For operating the SELECT-button, the ENTER-RESET-button and of the DIP-switches the front plate must be removed.

3.2.2 Parameter setting

The parameter settings are divided into three groups and can be find under point 6. In order to obtain the classifying mode, the corresponding DIP-switches are to be switched on. For leaving this mode it is necessary to terminate at first the actual entries and set the DIP-switches to OFF-position. for greatest possible data safety all set values are memorized in an EEPROM. No buffer battery is required for this.

3.2.3 Parameter selection

Within the classifying mode the parameters are scrolled through the display by means of the SELECT-button, until the parameter to be changed has attained. Closing the DIP-S1 enables reverse scrolling.

3.2.4 Input

The input or modification of the selected parameter is initiated by the ENTER-button. The cursor position is then changed by the ENTER-button as well. Pressing of the SELECT-button causes an up-counting of the digit marked by the cursor. When all cursor positions are keyed through, return to parameter selection takes place by means of the ENTER-button.

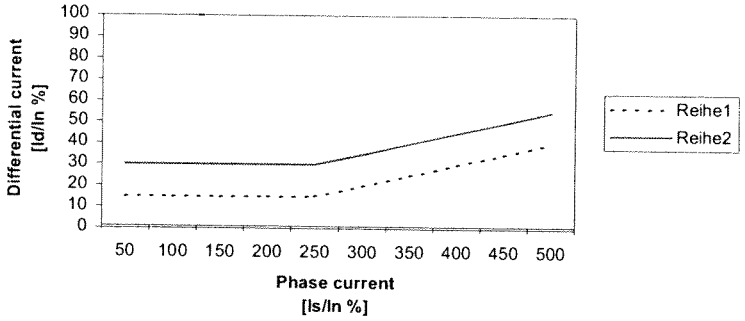
3.4 Fault signal

The relay output A3 may optionally pre-selected for common fault signal or operation signal (Para. B4).

In case common fault signal has classified, the relay A3 is de-energized along with the first response event and remains in this condition as long as the event is active (point 3.8).
In case operation signal has classified, the relay A3 is energized along with connection of the auxiliary voltage. The relay A3 is de-energized in case the auxiliary voltage fails or the internal device monitoring responds.

3.5 Tripping

During operation the measured values are compared after running-down of each measuring interval to the adjusted limit values for warning and tripping. On attaining the limit values the corresponding relay is triggered. The corresponding LEDs for ALARM or TRIP will light. Furthermore the LEDs ID1, ID2 or ID3 will signal, on which phase the differential current has been exceeded. The tripping function is described by the following diagram:



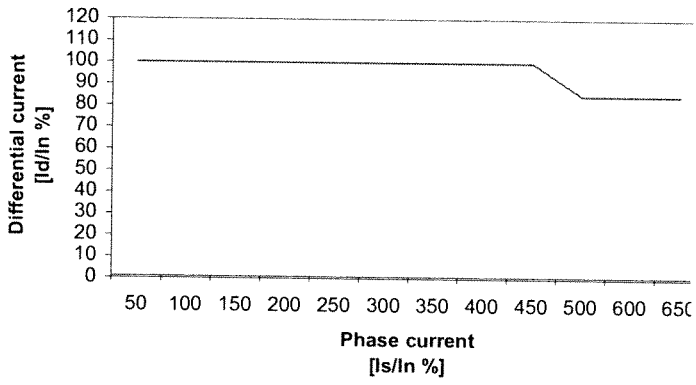
View 3: Tripping function

Line 1: pre-warning range = ALARM
Line 2: tripping range = TRIP

If the differential current has reached Id the pre-set value for pre-warning (view 3 : 15 %, Para. B1), the relay A1 is energized (pre-warning) after running-out of the pre-set delay time(Para. B2).
Attains Id the limit value tripping(Abb.3: 30 %, Para. A4), the relay A2 is energized after running-out of the pre-set delay time (Para. A5). The kink-point (Para. B3) is adjustable in the range of 50 % to 500 %. If the phase current exceeds the pre-set kink-point (view 3: 200%) the pre-warning and tripping characteristic is raised by 10 % each per 100% Is/Id.

These setting possibilities are superseded by two tripping events:

1. Differential current Id/In > 100 % causes immediate disconnection without delay time.
2. Differential current Id/In > 85 % at Is/In ■500% causes immediate undelayed disconnection as well.



View 4: tripping range

In case of very small currents (Is <5% at $I_{Nom.}$) no tripping follows.

3.2.5 Coding

In order to make an unauthorized modification difficult, the classifying mode can be also left in a coding manner.

Text window:

PARAMETERSELECT:
CODING WITH ENT

and then press the ENTER-button.

Now all parameters are protected against unauthorized or accidental modification and it can be looked at only!

If the coding shall be cancelled, so the DIP-S2 has to be set to ON, ENTER- button kept pressed and the SELECT- button pushed three times.

3.3 Analogue outputs

There are two parameterized analogue outputs on the FDS1. Analogue output 1 0(2) – 10V (Para.B10 –13) or analogue output 2 (Para.B14 – 17).The following measurements can be assigned to the analogue outputs.

No.	Measurement	Display
1	Internal current 1	I1 int
2	External current 1	I1 ext
3	Internal current 2	I2 int
4	External current 2	I2 ext
5	Internal current 3	I3 int
6	External current 3	I3 ext
7	Differential current 1	Id1 A
8	Differential current 2	Id2 A
9	Differential current 3	Id3 A
10	Stable current 1	Is1 A
11	Stable current 2	Is2 A
12	Stable current 3	Is3 A

Figure 3

The start and end values can be set as parameters. The parameterization is made in the valid number range (point 6, Para. B12-13, Para. B16-17).

Example :

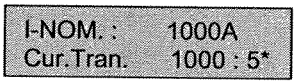
Analogue output 1 is to be assigned to internal current 1. The output is to operate in the range of 0A to 500A.

Start value : 0A
End value : 500A

The parameterized start value of 0A corresponds to a voltage of 0V and an end value of 10 V at 500A. The values in between will be output, lineraly increasing, on analogue output 1.

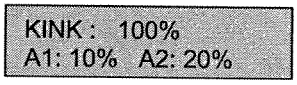
When pressing the SELECT- button, additional indications are possible:

Nominal current and CT ratio



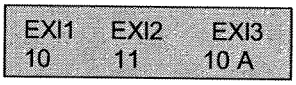
*In 1A graduated circles a "1" will be indicated

Kink point and trip value



Internal current

External current



Basic frequency

If the SELECT- button is not pressed again, the standard indication will appear after running-down of approx. 10 s.

3.6 Blocking of tripping

There are two different possibilities for blocking the trip action:

— Blocking takes place my means of the input E1. The blocking period starts with the rising flank of E1 and ends after elapsed time, pre-set by classifying (Para. B8). A new blocking is only possible after removing the signal, connected to (flank-triggered).

— Blocking by modification of the differential current. If the differential current change, from one measuring interval to the next one, exceeds the limit (Para. A7) pre-set by classifying, tripping is blocked as well for the pre-set period (Para. B8). This blocking can be switched off while the value is classified to 0% (Para. A7).

During blocking period the LED „RELEASE" extinguishes.

3.7 Reset after tripping

Reset after pre-warning or tripping action takes place as typical manually by means of the RESET-button (view 1) or via the input E2.

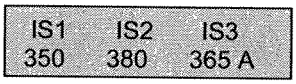
Automatic reset may be classified (Para. B5 and B6). The reset time can be adjusted in the range from 0.0 until 99.9 s (Para. B7).

3.8 Scrolling through the display

During operation mode the standard indication is shown on the display. That indicates, according to the pre-set of Parameter B9, the phase currents or the differential currents in ampere or percent referred to I_{nom}.
Following indications can be scrolled through by the ENTER- button:

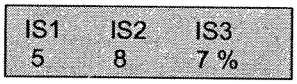
Indication of the phase currents in amps:

Here the mean value of the internal and external current of each phase is indicated.



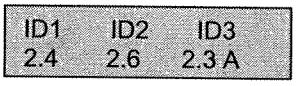
Indication of the phase currents in percent:

Here the mean value of the internal and external current of each phase is indicated, referred to the pre-adjusted nominal current.



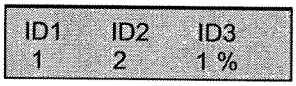
Indication of the differential current in amps:

Here the current difference between internal and external current in amps is indicated. Dependent on the nominal current, Id is indicated with or without decimal dot.
At $I_{nom} \leq 100$ A the indication takes place along with decimal dot.



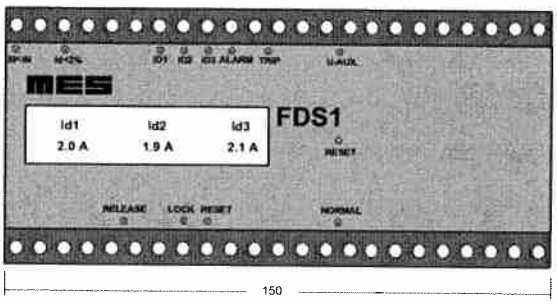
Indication of the differential currents in percent:

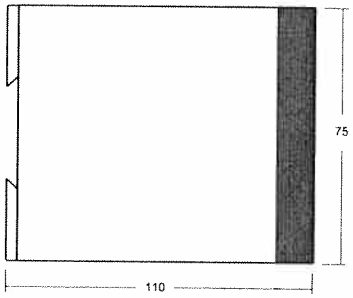
Here the current difference of internal and external current is indicated in percent, referred to the nominal current.



The selected indication has no influence on the tripping characteristic!
If the ENTER- button is not pressed again, the standard indication will appear after running-down of approx. 10 s.

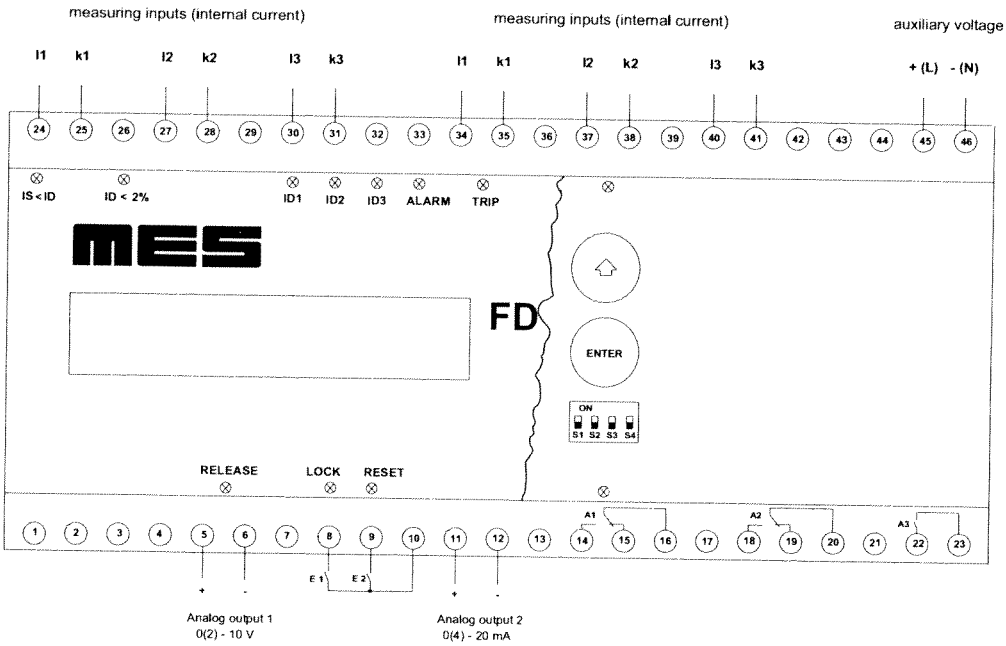
5.0 DIMENSIONS





View 4

4.0 CONNECTING DIAGRAM



Parameter Input:

SELECT Button

ENTER-
RESET-Button

DIP-Switch
= ON
= OFF

Outputs:

A1: Limit value 1, "ALARM" (energized on attained limit value, Para. B1)
A2: Limit value 2, "TRIP" (energized on attained limit value, A4)
A3: Refer to 3.5

Inputs:

E1 : Lock
E2 : Reset

Internal circuit: e.g. CT in generator-star point
External circuit: e.g. CT in the switchboard

For access to SELECT-, ENTER/RESET button and DIP-switch front cover to be removed

View 3

Para. No.	Parameter	Display range	Basic pre-set	Setting Factory	Setting Comm.
B	**Extended list** DIP 2 and 3 = ON				
10	Analogue output 1	ANALOG 1: 0-10V / 2-10V	ANALOGUE 1: 2-10 V		
11	Analogue output 1	ANALOG 1: see 3.3	I1 int		
12	Start value	AN1 START 0 – 9999A	0 A		
13	Final value	AN1 END 0 – 9999A	1000 A		
14	Analogue output 2	ANALOG 2: 0-20mA / 4-20mA	ANALOGUE 2: 4-20 mA		
15	Analogue output 2	ANALOG 2: see 3.3	I1 int		
16	Start value	AN2 START 0 – 9999A	0 A		
17	Final value	AN2 END 0 – 9999A	1000 A		

Para. No.	Parameter	Display range	Basic pre-set	Setting Factory	Setting Comm.
C	**CT correction** DIP 2 and 4 = ON				
1	CT correction path I1 internal current	IK1 INTERN: 0.5 – 1.500	1.000		
2	CT correction path I1 external current	IK1 EXTERN: 0.5 – 1.500	1.000		
3	CT correction path I2 internal current	IK2 INTERN: 0.5 – 1.500	1.000		
4	CT correction path I2 external current	IK2 EXTERN: 0.5 – 1.500	1.000		
5	CT correction path I3 internal current	IK3 INTERN: 0.5 – 1.500	1.000		
6	CT correction path I3 external current	IK3 EXTERN: 0.5 – 1.500	1.000		

Coding Switch					
Function	**DIP S1**	**DIP S2**	**DIP S3**	**DIP S4**	
Operating condition	OFF	OFF	OFF	OFF	
Set Parameter A	OFF	**ON**	OFF	OFF	
Set Parameter B	OFF	**ON**	**ON**	OFF	
Set Parameter C	OFF	**ON**	OFF	**ON**	
Scroll backward Parameter A,B and C	**ON**	...	...	...	

6.0 SET VALUES AND PARAMETER SETTINGS

Electrical values of the equipment:

Nominal current	I_n= A
Current transducer transmission intern	/ A
Current transducer transmission extern	/ A

Para. No.	Parameter	Display range	Basic pre-set	Setting Factory	Setting Comm.
A	**Basic list** DIP 2 = ON				
1	Generator Nominal current	I-NOM : 0...9999 A	1000 A		
2	**1A graduated circles** Transformer ratio internal / external	TRANSF 1 : 0...9999	1:0200		
2	**5A graduated circles** Transformer ratio internal / external	TRANSF 5 : 0...9999	5:1000		
3	Trip value	SHUTOFF: 0 – 100 %	20 %		
4	Delay time Tripping	T-SHUTO: 0.0 – 99.9s	0.0 s		
5	Basic frequency	NOM. FREQ. 50 / 60Hz	50 Hz		
6	Current change for autoblocking	ID-MAX. : 0.0 – 100%	25 %		
7	Displaytext language	SPRACHE DEUTSCH / LANGUAGE ENGLISH	SPRACHE DEUTSCH		

Para. No.	Parameter	Display range	Basic pre-set	Setting Factory	Setting Comm.
B	**Extended list** DIP 2 and 3 = ON				
1	Pre-warn. value	PREWARN. : 0 – 100 %	10 %		
2	Delay time Pre-warning	T-PREW. : 0.0 – 99.9 s	5.0 s		
3	Kink point of trip characteristic	I-KINKP : 50 – 500%	100 %		
4	Output relay A3	A3 OPERATION/ A3 COLL. FAULT	A3 OPERTING SIGNAL		
5	Pre-warning reset	PREWARNRES. E2 / AUTO	E2		
6	Tripping reset	SHUTOFF RES. E2 / AUTO	E2		
7	Reset time	T-RESET : 0.0 – 99.9s	1.0 s		
8	Trip blocking	T-LOCK : 0.0 – 99.9S	0.2 s		
9	Standard indication	INDICATION Is(A) / Is(%) Id(A) / Id(%)	INDICATION Id(%)		

7.0 TECHNICAL DATA

Measuring current	... / 1 A or ... / 5 A
Measuring range	... / 1A 0,1 - 3,5A AC .../ 5A 0,5 - 18 A AC
Measuring inputs	50 x I_{nom} 1 ms
Burden	0.25 VA, at I_{nom}= 5 A
Overload	3.5 x I_{nom} permanent
Frequency	45 – 65 Hz, depend. on Para. A6
Fault at nominal frequency	<0.5 % of final value
Auxiliary voltage	19 – 32 VDC
Consumption	approx. 3 VA (24 VDC)
Analogue outputs	Potential-separated against each other and against auxiliary voltage Analogue output 1 (U) : Burden > 2,7 kΩ Analogue output 2 (I) : Burden < 500 Ω
Relay outputs	230 V AC/DC , 2 A
Clock / Date	maintenance-free / 2000 suitable
Test voltage	2.5 kV
Ambient temperature	0 ... +50 °C
Casing	plastic Makrolon 8020 grey / VDE 0100 / VBG4
Dimensions	W150 x H75 x D110 mm
Mounting	on standard rail according DIN 50022 or screw mounting
Degree of protection	IP 20
Weight	670 g
Mounting position	any
Regulations	VDE 0160 / EN50178 VDE 0435 part 303 VDE 0110 IEC 255-6
EMC comparability and CE-marking	Interference emitting range EN 50081-1, for industrial environment Interference rejection range EN 50082-2, for industrial environment

Technical hint:

At application in the vicinity of magnetic fields with energy-technical frequencies the measuring value may, at field strength > 100 A/m, be falsified.

At strong HF-radiation (80 - 1000 MHz >= 10 V/m) we recommend to install the measuring wires in shielded manner, in order to ensure the measuring accuracy.

Subject to technical modifications!

MES
MULTIFUNKTIONALE ENERGIE SYSTEME

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