Diff3
High-Impedance or Flux-Balance Based Differential Protection for Generators and Motors

Contents

1. Introduction

1.1 Features

- Three-phase current differential protection based on high-impedance or flux-balancing principle providing winding short-circuit protection for generators and motors
- Adjustable operate value
- Instantaneous or definite time (DT) operation
- Delayed trip output for the circuit-breaker failure protection (CBFP) function
- High stability at external faults, also with partially saturated current transformers
- Short operate times at faults occuring in the zone to be protected (internal faults), also with partially saturated current transformers

1.2 Application

This document specifies the function of Diff3, the three-phase differential protection for generators and motors based on high-impedance or flux-balancing principle. The function block is used in products based on the RED 500 Platform.

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Figure 1.2.-1 Protection diagram symbol of Diff3 (For IEC symbols used in single line diagrams, refer to the manual Technical Descriptions of Functions, Introduction, 1MRS750528-MUM)

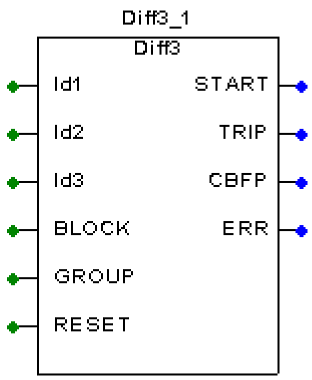

Figure 1.2.-1 Function block symbol of Diff3

1.3 Input description

Name	Type	Description
Id1	Analogue signal (SINT)	Input for measuring the differential current of phase L_1
Id2	Analogue signal (SINT)	Input for measuring the differential current of phase L_2
Id3	Analogue signal (SINT)	Input for measuring the differential current of phase L_3
BLOCK	Digital signal (BOOL, active high)	Blocking signal of Diff3
GROUP	Digital signal (BOOL, active high)	Control input for switching between the settings groups 1 and 2. When GROUP is FALSE, group 1 is active. When GROUP is TRUE, group 2 is active.
RESET	Reset signal (BOOL, pos. edge)	Input signal for resetting the trip signal and registers of Diff3

1.4 Output description

Name	Type	Description
START	Digital signal (BOOL, active high)	Start signal
TRIP	Digital signal (BOOL, active high)	Trip signal
CBFP	Digital signal (BOOL, active high)	Delayed trip signal for circuit-breaker failure protection (CBFP)
ERR	Digital signal (BOOL, active high)	Signal for indicating a configuration error

2. Description of operation

2.1 Configuration

If the relay is not yet configured, the measuring devices and signal types for the analogue channels are selected and configured in a special dialogue box of the Relay Configuration Tool included in the CAP 505 Tool Box. Digital inputs are configured in the same programming environment (the number of the selectable analogue inputs, digital inputs and digital outputs depends on the hardware used).

When the analogue channels and digital inputs have been selected and configured in the dialogue box, the inputs and outputs of the function block can be configured on a graphic worksheet of the Relay Configuration Tool. The differential phase currents (e.g. I_{L1}, I_{L2} and I_{L3} or I_{L1b}, I_{L2b} and I_{L3b}) are connected to the corresponding Id1, Id2 and Id3 inputs of the function block. Digital inputs are connected to the boolean inputs of the function block and in the same way, the outputs of the function block are connected to the output signals.

2.2 The measuring configuration based on high-impedance principle

The phase differential currents can be measured via the measuring configuration presented in Figure 2.2.-1 below and connected to the chosen analogue inputs of the relay.

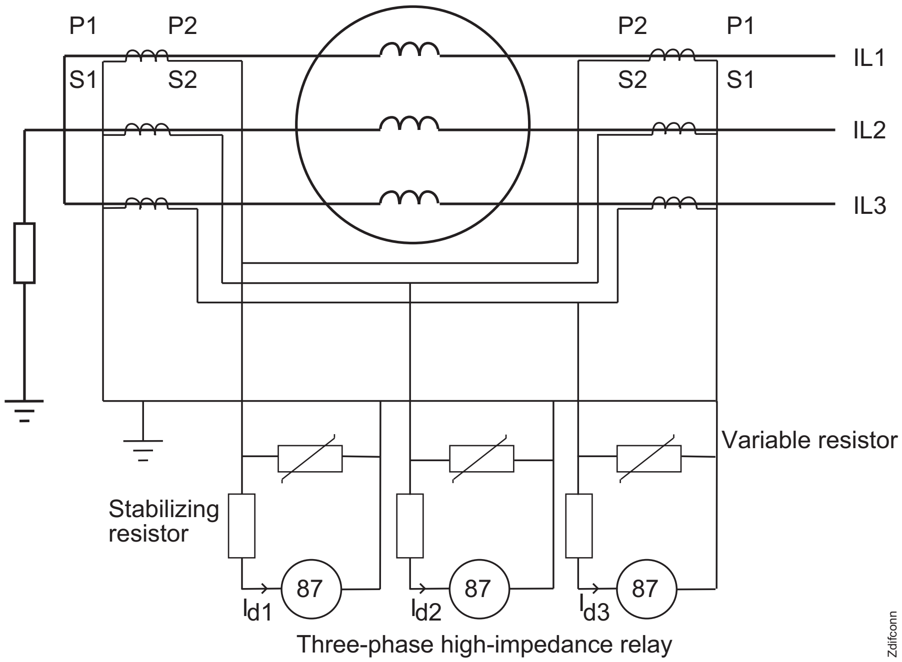

Figure 2.2.-1 Three-phase differential protection for generators and motors based on high-impedance principle

The external measuring configuration for every phase is composed of a stabilizing resistor and two current transformers measuring the compared phase currents (Figure 2.2.-1). A variable resistor is needed if high overvoltages are expected. The value of the stabilizing resistor can be calculated using the formula

$$R_s = \frac{U_s}{I_r} \qquad (1)$$

where

R_s	the resistance of the stabilizing resistor
U_s	the stabilizing voltage of the relay
I_r	the current value representing the function block setting

The stabilizing voltage can be calculated by the formula

$$U_s = \frac{I_{kmax}}{n}(R_{in} + R_m) \qquad (2)$$

where

I_{kmax}	the highest through-fault current
n	the turns ratio of the current transformer
R_{in}	the secondary internal resistance of the current transformer
R_m	the resistance of the secondary circuit loop

Additionally it is required that the knee-point voltages (U_k) of the current transformers are at least twice the value of the stabilizing voltage (U_s).

Note! The current transformers should be of the same type and the burdens of the current transformers in every phase should be the same. This makes it possible to use the same value for the stabilizing resistor and the same value for the “Basic setting” parameter in every phase.

For more information about calculating the value of the stabilizing resistor and choosing the current transformers refer to section “Recommendations for current transformers”.

Note! If the differential protection is wanted to be established without stabilizing resistors, the flux-balancing principle described in the next section can be utilized. Alternatively, if six currents are to be measured, the Stabilized Three-Phase Differential Protection for Generators (Diff6G) can be used.

2.3 The measuring configuration based on flux-balancing principle

A measuring configuration according to the flux-balancing principle is also possible. In this arrangement, no stabilizing resistors are needed. This configuration, however, requires the use of core-balance transformers. The compared currents, the one at the line end and the other at the neutral end, are both measured by the same core-balance transformer.

In this scheme, the currents flowing through one core-balance transformer cancel each other out when there is no fault within the protected area. When a fault occurs within the protected zone, the currents flowing through the core-balance transformer amplify each other and the differential protection operates.

Rogowski coils can also be used to measure the currents when using this scheme.

The configuration is presented in Figure 2.3.-1 below.

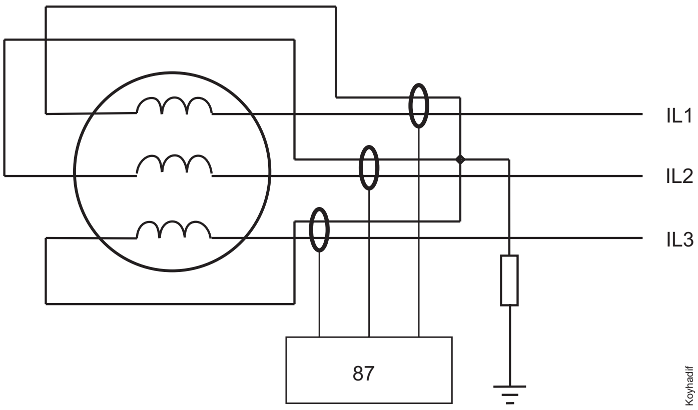

Figure 2.3.-1 Flux-balancing differential protection for generators and motors

Note! If six current transformers are to be used, it is strongly recommended that the high-impedance principle described in the previous section or the Stabilized Three-Phase Differential Protection for Generators (Diff6G) is utilized instead of a summing configuration where two current transformers are connected in series to constitute a differential current.

2.4 Operation criteria

When the high-impedance principle is applied, the operating characteristic of the function block is determined by the “Basic setting” parameter and the stabilizing resistor. In the flux-balancing configuration, there is no stabilizing resistor and the operating characteristic is determined purely by the “Basic setting” parameter. The setting is the same for each phase. When the differential current exceeds the “Basic setting” value, the differential function block trips unless it is blocked by an external blocking signal BLOCK.

Note! When the flux-balancing configuration is applied, a value of 5% or greater is recommended to be used for the “Basic setting” parameter, especially when Rogowski sensors are used. A more sensitive value may lead to false tripping during motor start-up.

In the high-impedance configuration, the value of the stabilizing resistor, which has to be calculated before installation and commissioning, mainly determines the stability of the relay. The “Basic setting” allows for fine tuning the sensitivity of the protection.

2.5 Recommendations for current transformers

2.5.1 High-impedance principle

The sensitivity and reliability of differential current protection stabilized through a resistor are strongly related to the current transformers used. The number of turns of the current transformers that are part of the same differential current circuit should be the same. Moreover, the current transformers should have the same transformation ratio.

To make the operation of the relay fast and reliable for in-zone faults, the knee-point voltage has to be twice the stabilizing voltage. The stabilizing voltage U_s of the function block is given by equation (2) in section “The measuring configuration based on high-impedance principle”. The required knee-point voltage U_k of the current transformer is calculated as follows:

$$U_k = 2 \text{ x } U_s \tag{3}$$

The factor 2 is used when no operate delay is permitted for the protection.

The sensitivity requirements for the protection are jeopardized if the magnetizing current of the current transformers at the knee-point voltage is too high. The I_{prim} value of the primary current at which the function block operates at certain settings can be calculated as follows:

$$I_{prim} = n \text{ x } (I_r + I_u + m \text{ x } I_e) \tag{4}$$

where

n	the transformation ratio of the current transformer
I_r	the current value representing the function block setting
I_u	the current flowing through the protection varistor
m	the number of current transformers included in the protection
I_e	the magnetizing current of one current transformer

The value I_0 given in many catalogues is the excitation current at knee-point voltage. Writing $I_e = 0.5 \text{ x } I_0$ gives a realistic value for I_{prim} in equation (4).

The choosing of current transformers can be divided into following procedures:

1. The nominal current I_n of the protected winding has to be known, since it also affects how high I_{kmax} is. Normally, the I_{kmax} value for generators is $I_{kmax} \approx 6 \text{ x } I_n$.

2. The nominal primary current I_{1n} of the CT (current transformer) must be higher than the nominal current of the protected winding. The choice of the CT also specifies R_{in}.

3. The required U_k is calculated using the formula (3). If the U_k of the CT is not high enough, another CT has to be chosen. The value of U_k is given by the manufacturer or in some cases it can be estimated (see equation (5) below).

4. The sensitivity I_{prim} is calculated with the formula (4). If the achieved sensitivity is sufficient, the present CT is chosen. If better sensitivity is needed, a CT with a bigger core is chosen.

If other than class X current transformers are used, an estimate for U_k can be calculated as follows:

$$U_k = 0.8 \times F_a \times I_{2n} \times (R_{in} + R_m) \qquad (5)$$

where

F_a	the actual accuracy limit factor
I_{2n}	the rated secondary current of the current transformer
R_{in}	the secondary internal resistance of the current transformer
R_m	the resistance of the secondary circuit loop

If the rated accuracy limit factor F_n is used in equation (5) instead of F_a, also R_m has to be replaced with the rated burden of the current transformer.

Example of the required knee-point voltage and achieved sensitivity is given below where the value 6 x I_n is used as I_{kmax}. When calculating I_{prim}, the value $I_r =$ m x I_e has been given for the setting of the relay and the value $I_u = 0$ A for the current of the varistor. I_r depends on the application. However, it is recommended that $I_r \geq$ m x I_e. The number of CTs connected in parallel is here m = 2.

Note 1: The formulas are based on worst-case analysis, i.e. choosing the CTs according to the criteria above (equation 3) results in an absolutely stable scheme. In some cases it is possible to achieve stability by knee-point voltages lower than stated by the formulae. The conditions of the network, however, have to be known well enough to ensure the stability. The following rule could be used.

1 If U_k is higher than required by the criterion, the stability is ensured.

2 If U_k is higher than 50 % of the value recommended by the criterion, the stability of the scheme is highly case-dependent.

3 If U_k is lower than 50 % of the value recommended by the criterion, stability is not achieved. Another current transformer has to be found.

Note 2: The stability analysis is based on the assumption that the ampere turns are the same for individual CTs. If that is not the case, the selectivity may be endangered. It is thus recommended that all the CTs used in the scheme are of the same type and preferably from the same batch. It is also required that the CTs in each phase are of the same type and the burdens of the CTs are also the same for each phase because the parameter “Basic setting” is the same for all the phases.

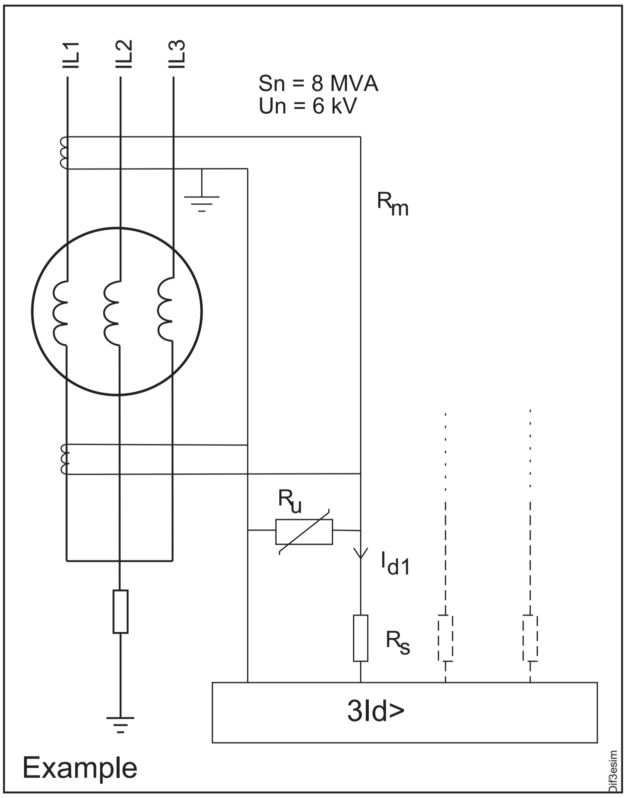

Figure 2.5.1-1 Differential protection of the generator (only one phase is presented in detail)

The protected generator has the following values:

S_n = 8 MVA

U_n = 6 kV

I_n = 770 A

I_{kmax} = 6 x I_n = 6 x 770 A = 4620 A

Let us choose the current transformer type KOFD 12 A 21 with the following values given by the manufacturer:

I_{1n} = 1000 A

I_{2n} = 1 A

U_k = 323 V

R_{in} = 15.3 Ω

I_0 = 0.012 A

If the length of the secondary circuit is 100 m (the whole loop being thus 200 m) and the area of the cross-section is 2.5 mm^2, then

R_m = 7.28 Ω/km x 2 x 0.1 km = 1.46 Ω

The required knee-point voltage can be calculated using the formula (3):

U_k = 2 x (4620 A / 1000) x (15.3 Ω + 1.46 Ω) = 155 V

The required value 155 V is lower than the value 323 V, which means that U_k of this current transformer is high enough.

As mentioned earlier, writing $I_e = 0.5 \times I_0$ gives a realistic value for I_{prim} in equation (4). By writing $I_u = 0$ and $I_r = m \times 0.5 \times I_0$, the following value for the sensitivity can be calculated:

$$I_{prim} = n \times m \times I_0 = 1000 \times 2 \times 0.012\ A = 24\ A\ (= 3\ \% \times I_n)$$

$$I_r = 2 \times 0.5 \times 0.012\ A = 0.012\ A$$

Because the parameter “Basic setting” is set in percent of the generator nominal current, the value for “Basic setting” will then be set to:

$$\text{Basic setting} = I_r / (I_n / n) = I_r \times n / I_n = 0.012\ A \times 1000 / 770\ A = 0.0156 = 1.6\%$$

The resistance of the stabilizing resistor can now be calculated as follows:

$$R_s = U_s / I_r = 78\ V / I_0 = 78\ V / 0.012\ A = 6500\ \Omega$$

Let us choose $I_r = 2 \times 12$ mA = 24 mA as the relay setting and assume $I_u = 30$ mA. The following sensitivity is achieved as a result:

$$I_{prim} = n \times (I_r + I_u + m \times I_e) = 1000 \times (24 + 30 + 12)\ mA = 66\ A\ (= 9\ \% \times I_n)$$

The value for “Basic setting” will then be set to:

$$\text{Basic setting} = I_r / (I_n / n) = I_r \times n / I_n = 0.024\ A \times 1000 / 770\ A = 0.0312 = 3.1\%$$

The resistance of the stabilizing resistor is now

$$R_s = U_s / I_r = 78\ V / 24\ mA = 3250\ \Omega$$

2.5.2 Flux-balancing principle

When the function block is used with the flux-balancing principle, there are no extra requirements for the measuring devices but the core-balance transformers and Rogowski coils used in an ordinary overcurrent protection are adequate here as well.

2.6 Setting groups

Two different groups of setting values, group 1 and group 2, are available for the function block. Switching between the two groups can be done in the following three ways:

1) Locally via the control parameter “Group selection”[1)] of the HMI

2) Over the communication bus by writing the parameter V2[1)]

3) By means of the input signal GROUP when allowed via the parameter “Group selection” (i.e. when V2 = 2[1)]).

[1)] Group selection (V2): 0 = Group 1; 1 = Group 2; 2 = GROUP input

The selected setting group is valid immediately after switching. The control parameter "Active group" indicates the setting group which is valid at a given time.

2.7 Test mode

The START, TRIP and CBFP digital outputs of the function block can be activated with separate control parameters for each output either locally via the HMI or externally via the serial communication. When an output is activated with the test parameter, an event indicating the test is generated.

The protection functions operate normally while the outputs are tested.

2.8 START, TRIP and CBFP outputs

The output signal START is always pulse-shaped. The minimum pulse width of the START and TRIP output signals is set via a separate parameter in the HMI or in serial communication. If the start situation is longer than the set pulse width, the START signal remains active until the start situation is over. The output signal TRIP may have a non-latching or a latching feature. When the latching mode has been selected, the TRIP signal remains active until the output is reset even if the operation criteria have been reset.

The function block provides a delayed trip signal CBFP after the TRIP signal unless the fault has disappeared during the set CBFP time delay. In circuit-breaker failure protection the CBFP output can be used to operate a circuit breaker in front of the circuit breaker of the machine. The control parameter “Trip pulse” also sets the width of the CBFP output signal. The CBFP signal is always non-latching.

2.9 Resetting

The TRIP output signal and the registers can be reset via the RESET input, or over the serial bus or the local HMI.

The operation indicators, latched trip signal and recorded data can be reset as follows:

	Operation indicators	Latched trip signal	Recorded data
RESET input of the function block [1]		X	X
Parameter F100V013[1]		X	X
General parameter F001V011 [2]	X		
General parameter F001V012 [2]	X	X	
General parameter F001V013 [2]	X	X	X
Push-button C [2]	X		
Push-buttons C + E (2 s) [2]	X	X	
Push-buttons C + E (5 s) [2]	X	X	X

[1] Resets the latched trip signal and recorded data of this particular function block.
[2] Affects all function blocks.

3. Parameters and events

3.1 General

- Each function block has a specific channel number for serial communication parameters and events. The channel for Diff3 is 100.

- The data direction of the parameters defines the use of each parameter as follows:

Data direction	Description
R, R/M	Read only
W	Write only
R/W	Read and write

- The different event mask parameters (see section “Control settings”) affect the visibility of events on the HMI or on serial communication (LON or SPA) as follows:

Event mask 1 (FxxxV101/102)	SPA / HMI (LON)
Event mask 2 (FxxxV103/104)	LON
Event mask 3 (FxxxV105/106)	LON
Event mask 4 (FxxxV107/108)	LON

For example, if only the events E3, E4 and E5 are to be seen on the HMI of the relay terminal, the event mask value 56 (8 + 16 + 32) is written to the “Event mask 1” parameter (FxxxV101).

In case a function block includes more than 32 events, there are two parameters instead of e.g. the “Event mask 1” parameter: the parameter “Event mask 1A” (FxxxV101) covers the events 0...31 and “Event mask 1B”(FxxxV102) the events 32...63.

3.2 Setting values

3.2.1 Actual settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Basic setting	S1	0.5…50	%	0.5	R	Lowest ratio of differential and nominal current to cause a trip
Operate time	S2	0.03...0.50	s	0.03	R	Operate time in DT mode

3.2.2 Setting group 1

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Basic setting	S41	0.5…50	%	0.5	R/W	Lowest ratio of differential and nominal current to cause a trip
Operate time	S42	0.03...0.50	s	0.03	R/W	Operate time in DT mode

3.2.3 Setting group 2

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Basic setting	S71	0.5…50	%	0.5	R/W	Lowest ratio of differential and nominal current to cause a trip
Operate time	S72	0.03...0.50	s	0.03	R/W	Operate time in DT mode

3.2.4 Control settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	V1	0...2 [1)]	-	2	R/W	Selection of operation mode
Group selection	V2	0…2 [2)]	-	0	R/W	Selection of the active setting group
Active group	V3	0 or 1 [3)]	-	0	R/M	Active setting group
Trip signal	V4	0 or 1 [4)]	-	0	R/W	Selection of latching feature for the TRIP output
Trip pulse	V5	40…1000	ms	40	R/W	Minimum pulse width of TRIP and CBFP
CBFP time	V6	100…1000	ms	100	R/W	Operate time of the delayed trip CBFP
Start pulse	V7	0…1000	ms	0	R/W	Minimum pulse length of START signal
Reset registers	V13	1=Reset	-	0	W	Resetting of latched trip signal and registers
Test START	V31	0 or 1[5)]	-	0	R/W	Testing of START
Test TRIP	V32	0 or 1 [5)]	-	0	R/W	Testing of TRIP
Test CBFP	V33	0 or 1 [5)]	-	0	R/W	Testing of CBFP
Event mask 1	V101	0...1023	-	783	R/W	Event mask 1 for event transmission (E0 ... E9)
Event mask 2	V103	0...1023	-	783	R/W	Event mask 2 for event transmission (E0 ... E9)
Event mask 3	V105	0...1023	-	783	R/W	Event mask 3 for event transmission (E0 ... E9)
Event mask 4	V107	0...1023	-	783	R/W	Event mask 4 for event transmission (E0 ... E9)

[1)] Operation mode 0 = Not in use; 1 = Definite time; 2 = Instantaneous
[2)] Group selection 0 = Group 1; 1 = Group 2; 2 = GROUP input
[3)] Active group 0 = Group 1; 1 = Group 2
[4)] Trip signal 0 = Non-latching; 1 = Latching
[5)] Test 0 = Do not activate; 1 = Activate

3.3 Measurement values

3.3.1 Input data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Current Id1	I1	0.000…60.000	x In	0.000	R/M	Differential current of phase L1
Current Id2	I2	0.000…60.000	x In	0.000	R/M	Differential current of phase L2
Current Id3	I3	0.000…60.000	x In	0.000	R/M	Differential current of phase L3
Input BLOCK	I4	0 or 1 [1)]	-	0	R/M	Status of the BLOCK signal
Input GROUP	I5	0 or 1 [1)]	-	0	R/M	Status of the signal for switching between the setting groups 1 and 2
Input RESET	I6	0 or 1 [1)]	-	0	R/M	Status of the signal for resetting the output signals of Diff3

[1)] Input 0 = Not active; 1 = Active

3.3.2 Output data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Output TRIP	O1	0 or 1 [1)]	-	0	R/M	Status of the trip signal
Output ERR	O2	0 or 1 [1)]	-	0	R/M	Status of the configuration error signal
Output START	03	0 or 1[1)]	-	0	R/M	Status of start signal

[1)] Output 0 = Not active; 1 = Active

3.3.3 Recorded data

3.3.3.1 General

The data of three last operations (operation 1...3) are recorded, and the values of the most recent operation always replace the data of the oldest operation. The registers are updated in the following order: Operation 1, Operation 2, Operation 3, Operation 1, Operation 2,...

3.3.3.2 Date and time

DT mode

The time stamp indicates the moment of the highest fault current during a period between the start situation and 50 ms after the tripping.

Instantaneous mode

The time stamp indicates the moment of the highest fault current during 50 ms after the tripping.

3.3.3.3 Currents

If the function block trips, all the recorded phase differential current values will originate from the same moment determined by the highest differential current. The values of the differential phase currents I_{d1}, I_{d2} and I_{d3} are recorded as multiples of the rated current I_n.

If the function block starts but does not trip, the highest fault current during start situation is recorded.

3.3.3.4 Status data

The status of the “Active group” parameter, which indicates the setting group valid for the recorded data, is recorded at the moment of tripping.

3.3.3.5 Duration

In the DT mode of operation, the duration of the start situation is recorded as a percentage of the set operate time.

3.3.3.6 Recorded data 1

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V201	YYYY-MM-DD	-	-	R/M	Recording date
Time	V202	hh:mm:ss.mss	-	-	R/M	Recording time
Current Id1	V203	0.000…60.000	x In	0.000	R/M	Differential current of phase L1
Current Id2	V204	0.000…60.000	x In	0.000	R/M	Differential current of phase L2
Current Id3	V205	0.000…60.000	x In	0.000	R/M	Differential current of phase L3
Active group	V206	0 or 1 [1)]	-	0	R/M	Active setting group
Duration	V207	0.0...100.0	%	0.0	R/M	Duration of start situation

[1)] Active group 0 = Group 1; 1 = Group 2

3.3.3.7 Recorded data 2

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V301	YYYY-MM-DD	-	-	R/M	Recording date
Time	V302	hh:mm:ss. mss	-	-	R/M	Recording time
Current Id1	V303	0.000…60.000	x In	0.000	R/M	Differential current of phase L1
Current Id2	V304	0.000…60.000	x In	0.000	R/M	Differential current of phase L2
Current Id3	V305	0.000…60.000	x In	0.000	R/M	Differential current of phase L3
Active group	V306	0 or 1 [1)]	-	0	R/M	Active setting group
Duration	V307	0.0...100.0	%	0.0	R/M	Duration of start situation

[1)] Active group 0 = Group 1; 1 = Group 2

3.3.3.8 Recorded data 3

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V401	YYYY-MM-DD	-	-	R/M	Recording date
Time	V402	hh:mm:ss. mss	-	-	R/M	Recording time
Current Id1	V403	0.000…60.000	x In	0.000	R/M	Differential current of phase L1
Current Id2	V404	0.000…60.000	x In	0.000	R/M	Differential current of phase L2
Current Id3	V405	0.000…60.000	x In	0.000	R/M	Differential current of phase L3
Active group	V406	0 or 1 [1)]	-	0	R/M	Active setting group
Duration	V407	0.0...100.0	%	0.0	R/M	Duration of start situation

[1)] Active group 0 = Group 1; 1 = Group 2

3.3.4 Events

Code	Weighting coefficient	Default mask	Event reason	Event state
E0	1	1	TRIP signal of Diff3	Reset
E1	2	1	TRIP signal of Diff3	Activated
E2	4	1	CBFP signal of Diff3	Reset
E3	8	1	CBFP signal of Diff3	Activated
E4	16	0	BLOCK signal of Diff3	Reset
E5	32	0	BLOCK signal of Diff3	Activated
E6	64	0	Test mode of Diff3	Off
E7	128	0	Test mode of Diff3	On
E8	256	1	START signal of Diff3	Reset
E9	512	1	START signal of Diff3	Activated

4. Technical data

Operation accuracies	Depends on the frequency of the current measured: f/f_n = 0.95...1.05: ± 2.5% of set value or ± 0.004 x I_n.
Trip time in instantaneous mode	Injected currents > 2.0 x operating current: f/f_n = 0.95...1.05 internal time < 20 ms total time [2] < 30 ms
Start time in definite-time mode	Injected currents > 2.0 x operating current: f/fn = 0.95...1.05 internal time < 20 ms total time [1] < 30 ms
Reset time	60...1020 ms (depends on the minimum pulse width set for the TRIP output)
Reset ratio	Typ. 0.95 (range 0.80…0.98)
Retardation time in instantaneous mode	This function block cannot retard but trips once the current exceeds the operate value.
Retardation time in definite-time mode	Total retardation time when the current drops below the start value [2] < 40 ms
Configuration data	Task execution interval (Relay Configuration Tool): 5 ms at the rated frequency f_n = 50 Hz

[1] Includes the delay of the signal relay
[1] Includes the delay of the heavy-duty output relay

Technical revision history	
Technical revision	**Change**
B	Support for definite time operation has been added