

RefleX Protection and Control

RefleX - 3001

**Differential protection for two-winding
and three-winding transformers
Restricted Earth Fault Protection**



2W/3W differential protection
REF protection
Model 3001

RefleX differential and REF protection for 2W or 3W transformer

Application

The RefleX differential relay is designed to protect high voltage two-winding and three-winding transformers. It can also protect small generators and busbars with up to 3 branches. The relay is extremely easy to use and its setting tools and menus are especially designed to enable easy setting and quick, cost-efficient operation.

Measurement

The two-winding transformer differential protection is formed by two RefleX units. Three-winding differential relays are formed by three Reflex units. The measured values are transmitted between the units through optical fibres. An inrush-current measurement is restraining the trip function during the energisation of the transformer. The currents are measured and the 1st, 2nd and 5th harmonic and extracted by fourier analysis.

REF function (independent of communication)

Local restricted Earth-Fault measurement between EF connection in the transformer neutral point current. Stabilized differential current principle, low impedance type. This function is operating independently of all other input modules, and is active even if the differential function is disabled by communication error.

Watchdog (system supervision)

The supervision function will alert the user by turning the green LED off and by closing the WD contact (C17-C18):

- when power supply is interrupted for more than 100ms
- when a fault occurs in one or more of the relay processors or memory.

Intermodule Communication Supervision

When there is an error in the optical fiber connection between the relay modules, then the supervision function will turn the green LED off and close the Intermodule-Bus Error contact (C13-C14). This enables the user to distinguish between internal errors, and errors in the external fiber connections.

In this case the REF function will still be active, although the REF trip signals cannot be distributed along the faulted or missing optical fibers to the other diff modules.

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Setting menu

(The values in this page are only informative examples, not recommended settings)

Diff. Module A IL1 124A IL2 120A IL3 123A	A separate description of alternative read-outs from the display is found in another section of this document	In-service display (default display) Displaying current in phase 1 Displaying current in phase 2 Displaying current in phase 3
Trip records	A separate description of the sub-menu "Trip Records" is found in another section of this document	Press "enter" here to display stored trip records After selecting a record use "arrow up" or "arrow down" to display additional information. Leave sub-menu by pressing "Esc".
Input references This is module A Voltage 132kV CT 500/5A In5A	_____ _____ _____	Data related to each input (module) Designate: Module A, Module B, (Module C) Rated voltage (reference) for power transformer CT ratio and rated relay current for this winding
Transformer data Ref.pwr. 100MVA Vectors A-B-C: YN-yn0-d11	_____ _____ _____	Power transformer data. Usually rated power for the "primary winding" Power transformer vectors are specified here in module A (mirrored to module B / C)
Diff. trip curve dI> 40% Bias 40% dI>> 500%	_____ _____ _____	Low diff. Setting (mirrored to module B/C) Bias slope setting (mirrored to module B/C) Unrestrained high diff. (mirrored to B/C) *) Please observe REF comment below
REF On Mod.A Voltage 132kV IREF 10/0.1A CT 100/1A In1A	_____ _____ _____	*) Please observe REF comment below REF on/off Module name Reference voltage REF trip level referred to neutral-point CT (Ig) Neutral-point CT ratio Relay rated current
Harmonic Block H2 20% H5 40%	_____ _____ _____	Harmonic blocking function 2. Harmonic blocking setting 5. Harmonic blocking setting
Common #1 CB fail backup: tCBF 0.2s	_____ _____	Common settings for the complete relay Breaker failure function delay
Comm. IEC ON Config Star Address 45 Meas. Value 1.2	_____ _____ _____ _____	Communication parameters Ring/star On/off Relay address (1..254) Value of measurand
YMD 2003-05-29 HMS 13:52:36 Password **** Freq. 50Hz	_____ _____ _____ _____	Year - month - day 24 hour clock Four-digit password (default 1111) Rated power system frequency

***) REF comment:**

If the communication between modules is broken, then the differential function is disabled, the green "OK indicator" in the relay front panel is turned "off" and a "communication error" message appears in the display. Although the green lamp is "off", the REF function is however still active, forming a backup during the time when the differential function is disabled.

When the communication is out of service, the REF trip will not be distributed to the other units as usual.

If it is required to trip all transformer breakers in that particular situation all trips should be hardwired enabling any trip signal from any unit to trip all transformer breakers.

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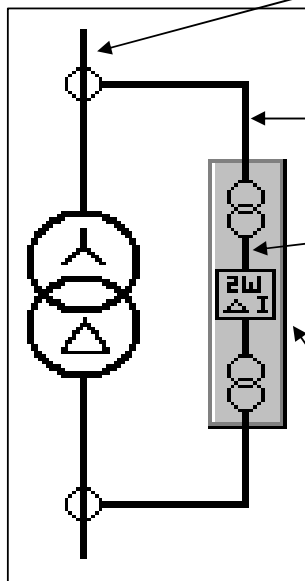
In-service displays, and error messages

Selecting between the different In-service displays is done by pressing "enter" when the display is active. Some of the displays are to be used mainly during commissioning. This is for instance the case for the differential currents. Under normal circumstances these values are of limited interest to the operational staff. After pressing "Esc" the display will return to the initial display: primary phase currents. This example is for a 2-winding transformer, displaying module A values.

Main menu:



Submenu, Displays:



```
Diff. Module A
IL1 124A prim.
IL2 120A prim.
IL3 123A prim.
```

The measuring displays is part of the main menu. Those are selected by pressing "Enter" multiple times.

Module identification line
Measured primary phase currents. This display is the usual in-service display

```
Diff. Module A
IL1 2.00A ∠ Ref°
IL2 2.01A ∠ -120°
IL3 2.03A ∠ +120°
```

Module identification line
Measured secondary phase-currents and angles before compensating with apparent intermediate current transformers.

```
Diff. Module A
Ic1 2.00A ∠ 0°
Ic2 2.01A ∠ -120°
Ic3 2.03A ∠ +120°
```

Module identification line
Calculated compensated currents and angle: after compensating with apparent intermediate current transformers.

```
Diff. current
Id1 3%
Id2 3%
Id3 2%
```

Differential current in percent of reference values
Differential current in percent of reference values
Differential current in percent of reference values

```
Restricted EF
Io 121A ∠ Ref°
Ig 110A ∠ -180°
```

Restricted earth measuring primary values
Vectorial sum of phase currents (3Io)
Measured current in transformer Y to ground connection

```
Communication
error. Check
intermodule
fiber bus.
```

This display only appears when if is an error in the physical intermodule bus. Possible causes may be failures in: intermodule optical fibers, module hardware or module power supply

```
Master module
is not defined.
Set one module
name: A
```

This display only appears if none of the modules is defined as "A". The "A" module is the master unit where all common settings are done. The relay must have one "A" module

```
The number of
RefleX modules
does not match
Transf.Vectors
```

This display only appears if there is a mismatch between the number of RefleX modules and the transformer type (2W diff or 3W diff) that is set in the "transformer data / Vectors" display.

```
Name or connect
modules in this
way: A-B-C
Present: A-B-C
```

This display only appears if module names are duplicated or out of sequence. Rename module: until the "present" line matches the suggested name-sequence (A-B or A-B-C)

```
Diff. module A
Check current
phase sequence
```

This display only appears when a "negative-sequence current" is measured. Indicates that the phase sequence is wrong (reverse rotating system)

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Trip-records sub-menu

All displays show recordings subsequent to relay tripping. The last five recordings are always stored. After a relay trip the display showing date and time of the trip automatically appears. By using ENTER followed by arrow up/down the user may access all information in the displays below. Each trip is automatically assigned a separate serial number. Only trip records (displays) with active information is stored and/or displayed after a trip.

Trip records

Trip 333
2001-12-24
12:13:14.123

This display is part of the main menu. After selecting a record use "arrow up" or "arrow down" to display additional information. Leave trip records by pressing "Esc".

Header (in this case looking at trip no. 333)
"trip 333" date
"trip 333" time

Trip 333
Differential*
Restricted EF
Remote Trip

Trip indication
Differential trip (indicated by a star)
Restricted Earth Fault trip (indicated by star)
Remote REF trip from other module (star)

Trip 333
IL1 951A prim.
IL2 120A prim.
IL3 123A prim.

Primary fault currents
Fault current in phase L1.
Fault current in phase L2.
Fault current in phase L3.

Trip 333
IL1 2.00A \angle Ref°
IL2 2.01A \angle -120°
IL3 2.03A \angle +120°

Secondary fault currents
Secondary fault phase-currents and angles before compensating with the apparent intermediate current transformers.

Trip 333
Restricted EF
Io 0.00A \angle Ref°
Ig 0.00A \angle 0°

Measured Restricted Earth Fault trip data:
E/F Current - primary sum of phase currents (3Io)
E/F Current - primary measured in the neutral point

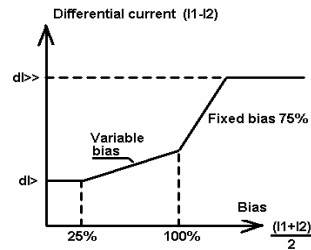
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Technical data

Differential module

Low differential current setting	dI>	10.0-100 % and ∞
High differential current setting	dI>>	200-2000% and ∞ (unrestrained)
Variable bias setting	Ibias	10.0-60.0 %
Min operating current		0.1 * In
Max operating current		75 * In
Typical trip time		38 ms (50 Hz system frequency)
Typical reset time		38 ms (50 Hz system frequency)
2.harmonic blocking setting	H2	10.0-100 % and ∞ of 1. Harmonic
5.harmonic blocking setting	H5	10.0-60.0 % and ∞ of 1. Harmonic

Characteristic



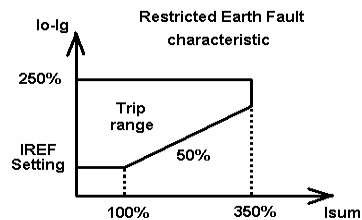
Restricted Earth Fault protection (REF protection)

Restricted Earth Fault trip level	IREF	0.10-1.0 A and ∞ (Ino = 1A)
	IREF	0.50-5.0 A and ∞ (Ino = 5A)
		(Settings referred to relay neutral point input)
Min operating current		0.1 * In (referred to relay neutral-point input)
Max operating current		2.5 * In (referred to relay neutral-point input)
Typical trip time		45 ms (50 Hz system frequency)
Typical reset time		45 ms (50 Hz system frequency)

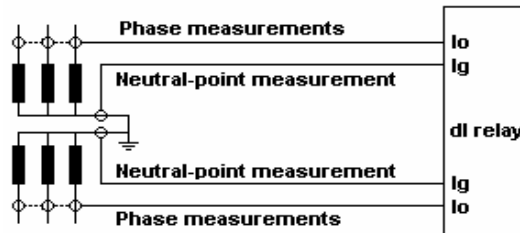
Characteristic

(Io-Ig and Isum in % of nominal current:)

Io = vectorial sum of phase currents $IL1+IL2+IL3$
 Isum = sum of phase current amplitudes $(IL1+IL2+IL3)/3$
 Ig = measured current in transformer Y-to-ground



Connection references



RefleX differential and REF protection for 2W or 3W transformer

Rated data for Protected Primary Unit (usually a transformer)

Reference power (Pref)	Ref. Power	0.5-500 MVA (Usually = Pn for HV winding)
Vector group	Vectors	Y or D connections in 30 degrees steps
Primary voltage (Un) for all sides	Voltage	0.2-999 kV (Tap changer in center position)

System

Module reference on HV, MV, LV sides	Module	A, B, C
Frequency		50 Hz
Factory default password		1111
Pulse extension circuit at all trip outputs		0,2 s

Intermodule bus supervision

Message after bus failure	Module	A, B, C: error message and trip block
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Communication (IEC 60 870-5-103 protocol)

Configuration system		Star or Ring
Address of protection equipment		1 to 254
Value of measurand (x In)		1.2 or 2.4
Optical fibre transmitters		Outputs D3,D5
Optical fibre receivers		Inputs D4,D6

Selection of standard information numbers (IEC 60870) in monitor direction (MDxxx)

Protection inactive (internal fault)	<18>
LED-reset	<19>
General trip	<68>
General start	<84>
Breaker failure	<85>
Measurands IN	<147>
Measurands IL1,2,3	<148>

Selection of standard information numbers (IEC 60870) in control direction (CDxxx)

LED-reset	<19>
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Circuit Breaker Failure Protection (CBFP)

Trip transfer delay. Recommended setting = 0.2s	0.05 - 1.00 s
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