Multi Differential Relay, MDR-2
DESCRIPTION OF OPTIONS

Option C4
Block differential current protection

- Description of option
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1. Warnings and legal information

Legal information and responsibility

DEIF takes no responsibility for installation or operation of the generator set and transformer. If there is any doubt about how to install or operate the generator/transformer set controlled by the unit, the company responsible for the installation or the operation of the set must be contacted.

The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Electrostatic discharge awareness

Sufficient care must be taken to protect the terminals against static discharges during the installation. Once the unit is installed and connected, these precautions are no longer necessary.

Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.

Definitions

Throughout this document a number of notes and warnings will be presented. To ensure that these are noticed, they will be highlighted in order to separate them from the general text.

Notes

The notes provide general information which will be helpful for the reader to bear in mind.

Warning

The warnings indicate a potentially dangerous situation which could result in death, personal injury or damaged equipment, if certain guidelines are not followed.

2. Description of option

ANSI numbers

Protection	ANSI no.
Differential current	87GT
Over-excitation	40

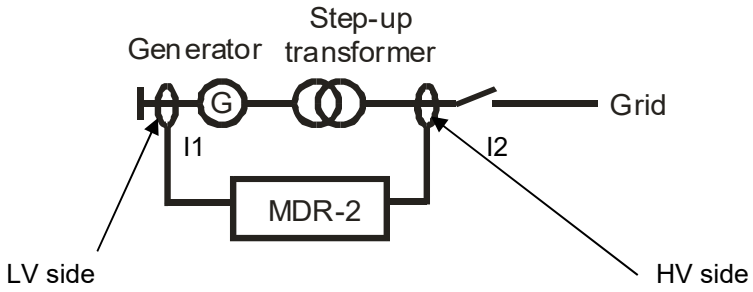
Option C4

Option C4 includes generator and transformer block differential current protection.

3. Functional descriptions

Generator and step-up transformer block

In principle, the generator and transformer block looks like this:



Due to the step-up transformer, the CTs have different ratios. This is handled by two different settings for the LV (generator) side and the HV (consumer/grid) side CTs.

Since the two currents on the LV and HV sides are not directly comparable, the MDR-2 will transform the LV currents into “virtual” HV side values in order to carry out the calculations.

Vector group compensation

The vector group compensation compensates for the vector shift between the LV and HV side of the step-up transformer.

The group designation is:

$$Vg = \frac{\text{Phase angle difference}}{30}$$

Vg hereby represents the HV side leading angle over LV side.

Furthermore, the designation uses D (delta) and Y (wye). The code starts with a capital letter for the high voltage (HV) side of the step-up transformer and lower case letter for the low voltage (LV) side.

In

4050 Step-up transformer winding configuration

a pre-defined set of usable vector groups exists.

The MDR-2 unit can only be used on systems, where the transformer vector group is one of the types stated in this document.

Inrush phenomenon and blocking

The inrush phenomenon occurs due to the start currents of the transformer. The start current is the current necessary to excite a transformer, until full excitation and normal operation conditions have been achieved. Depending on the individual transformer, this may last for several periods of the AC current flow. Since the inrush current in principle only appears on one side of the transformer, it will be identified as a differential current error if no further action is taken.

Other possible causes are external faults, voltage recovery after clearing of an external fault, change of type of external fault (like phase-to-ground fault turning into phase-to-phase-to-ground fault) and out-of-phase synchronising.

Since inrush generates high contents of second harmonic currents (100 Hz for 50 Hz systems), it can be used to detect the inrush and prevent false trips.

In option C4, the approach is to calculate the 2nd harmonic differential current value and compare it to the fundamental differential current value. If the 2nd harmonic content exceeds a certain value, an inrush is present and the differential current trip is blocked. An inrush phenomenon is present when the 2nd harmonic exceeds approx. 15 % of the fundamental current.

In case of a short circuit, 2nd harmonic will be below approx. 5 %.

Blocking of the differential current tripping during start-up is acceptable, since the 2nd harmonic differential current value is related in % to the fundamental differential current. Actually, if there is a differential current failure, then the value of the fundamental differential current will increase and the 2nd harmonic % value will decrease and thereby reset the blocking due to 2nd harmonic currents.

Over-excitation phenomenon and blocking

An over-excitation phenomenon causes a large differential current but may not cause a trip of the breaker. This means that the protection unit may not identify it as a fault situation. Over-excitation phenomena occur when the incoming voltage to the step-up transformer exceeds the nominal value.

The over-excitation phenomenon is characterised by large contents of 5th harmonic current. In order to eliminate an unintentional trip of the breaker due to an over-excitation phenomenon, the content of 5th harmonic differential current is supervised. An over-excitation phenomenon is present when the 5th harmonic exceeds 30 % of the fundamental differential current.

The MDR-2 unit can carry out both over-excitation alarm and blocking of differential trip.

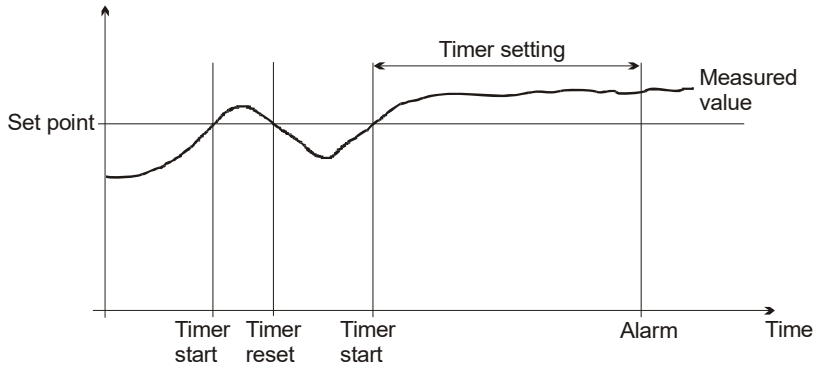
Alarms

All settings are in percent of:

- the HV side nominal values,
- the differential current harmonics 5th to 1st ratio (over-excitation).

The delay settings are all of the definite time type, that is, a set point and time is selected.

If the function is, for example, over-excitation, then the timer will be activated if the set point is exceeded. If the measured value goes below the set point value before the timer runs out, then the timer will be stopped and reset.



The output is activated when the timer runs out. The total delay will be the delay setting + the reaction time.

4. Parameter list

Parameter table description

The setup of parameters is done via the display or the PC utility software (USW). In the following, the settings are presented in tables.

For each setting, the table consists of the following possible adjustments:

Set point: The alarm set point is adjusted in the set point menu. The setting is a percentage of the nominal values.

Timer: The timer setting is the time that must expire from the alarm level is reached until the alarm occurs.

Relay output A: A relay can be activated by output A.

Relay output B: A relay can be activated by output B.

Enable: The alarm can be activated or deactivated. ON means always activated, RUN means that the alarm has run status. This means it is activated when the running signal is present.

Fail class: When the alarm occurs, the unit will react depending on the selected fail class.

Small differences due to the character of the parameters may exist between the individual tables.

For further information about the structure of the parameter descriptions, see the Designer's reference handbook.

Overview list

Transformer inrush	**Nominal settings**
1110 Transformer inrush current blocking for differential current	4010 Nominal settings
	4020 Current transformers I1
Over-excitation curr. detection and blocking	4030 Current transformers I2
1120 Over-excitation blocking for differential current	4040 Step-up transformer ratio
1130 Transformer over-excitation alarm	4050 Step-up transformer winding configuration

1110 Transformer inrush current blocking for differential current

Settings relate to fundamental differential current id.

No.	Setting		Min. setting	Max. setting	Factory setting
1111	Inrush blocking	2nd harmonic level	10 %	40 %	15 %
1112	Inrush blocking	Enable	OFF	ON	OFF

The setting relates to both warning and trip differential current values as well as fixed trip values. For additional information, see the Designer's reference handbook.

Over-excitation current detection and blocking

1120 Over-excitation blocking for differential current

Settings relate to the fundamental differential current ID.

No.	Setting		Min. setting	Max. setting	Factory setting
1121	Over-excitation	5th harmonic level	10 %	50 %	30 %
1122	Over-excitation	Enable	OFF	ON	OFF

The setting relates to both warning and trip differential current values as well as fixed trip values. For additional information, see the MDR-2 Designer's reference handbook.

1130 Transformer over-excitation alarm

Settings relate to the fundamental differential current ID.

No.	Setting		Min. setting	Max. setting	Factory setting
1131	Over-excitation	5th harmonic level	10 %	50 %	30 %
1132	Over-excitation	Time	0.10 s	10.00 s	1.00 s
1133	Over-excitation	Relay output A	R0 (none)	R5 (relay 5)	R0 (none)
1134	Over-excitation	Relay output B	R0 (none)	R5 (relay 5)	R0 (none)
1135	Over-excitation	Enable	OFF	ON	OFF

The over-excitation protection setting is very dependent on the individual transformer. It may even be undesirable. In this case, ENABLE is to be set to OFF.

Nominal settings

4010 Nominal settings

Nominal current relates to the high voltage (HV) consumer/grid side of the step-up transformer.

No.	Setting		Min. setting	Max. setting	Factory setting
4011	Nominal settings	Frequency	48.0 Hz	62.0 Hz	50.0 Hz
4012	Nominal settings	Current	1 A	10000 A	100 A

4020 Current transformers I1

CT ratio I1 is the setting for the measuring current transformers on the low voltage (LV) side of the step-up transformer. It is placed in the generator star point.

No.	Setting		Min. setting	Max. setting	Factory setting
4021	CT ratio I1	Current prim.	5 A	10000 A	2500 A
4022	CT ratio I1	Current sec.	1 A	1 A	1 A

The CT secondary side is only available as 1 A, when option C4 is selected.

4030 Current transformers I2

CT ratio I2 is the setting for the measuring current transformers on the high voltage (HV) side of the step-up transformer. It is placed on the HV side of the transformer.

No.	Setting		Min. setting	Max. setting	Factory setting
4031	CT ratio I2	Current prim.	5 A	10000 A	100 A
4032	CT ratio I2	Current sec.	1 A	1 A	1 A

The CT secondary side is only available as 1 A when option C4 is selected.

The CT ratios must relate to each other according to these equations:

$$0.625 \leq \frac{CTP_{I1} \cdot V_L}{I_n \cdot V_H} \leq 2$$

$$0.625 \leq \frac{CTP_{I2}}{I_n} \leq 2$$

$$0.5 \leq \frac{V_L \cdot CTP_{I1}}{V_H \cdot CTP_{I2}} \leq 2$$

Failure to do so will result in 0 value current measurements, protection alarms inhibit, and an alarm (ratio error) will appear.

V_H = High voltage side nominal voltage (4042)
V_L = Low voltage side nominal voltage (4041)
CTP_{I1} = CT Primary Current, I1 (low voltage side current transformer) (4021)
CTP_{I2} = CT Primary Current, I2 (high voltage side current transformer) (4031)
In = Nominal current, related to the high voltage side of the step-up transformer (4012)

4040 Step-up transformer ratio

No.	Setting		Min. setting	Max. setting	Factory setting
4041	Step-up trafo	Low voltage (LV)	230 V	32000 V	400 V
4042	Step-up trafo	High voltage (HV)	1.00 kV	70.00 kV	10.00 kV

4050 Step-up transformer winding configuration

No.	Setting		Min. setting	Max. setting	Factory setting
4051	Step-up trafo	Configuration	Dd0	Dy11	Dd0

The transformer ratio is used to convert all measured current values into equivalent HV side values in order to establish an equal current reference.

The following transformer winding connections are possible:

Winding connection	HV side	LV side	Phase angle shift (deg.)
Dd0*	Delta	Delta	0
Dd6	Delta	Delta	180
Dy1	Delta	Wye	-30
Dy5	Delta	Wye	-150
Dy7	Delta	Wye	150
Dy11	Delta	Wye	30
Yd1	Wye	Delta	-30
Yd5	Wye	Delta	-150
Yd7	Wye	Delta	150
Yd11	Wye	Delta	30

***** A transformer with Yy0 coupling is covered by choosing the Dd0 connection.