OGYD-EP

NUMERICAL BUS-BAR DIFFERENTIAL PROTECTION AND C.B. FAILURE PROTECTION based on optical fibre cable links

Field of application

The devices of the **EuroProt** complex protection family are modular devices. The modules are selected, assembled and configured according to the tasks to be performed. This information sheet describes one of the several possibilities: the **OGYD-EP** factory configuration. The general description concerning the **EuroProt** devices can be found in the document „**EuroProt** complex protection, hardware and software description and user's manual", (further "*EuroProt manual*").

The **OGYD-EP** factory configuration produced by PROTECTA Electronics Co. Ltd. is assembled to perform numerical bus-bar differential protection and circuit breaker failure protection functions.

The bus-bars play an important role in the high voltage electric power system. Since the bus-bar concentrates the short-circuit power, destructive effects caused by a fault, by a device failure, by a handling mistake or by any other reasons are very high. A high-speed bus-bar protection with high reliability can decrease the damage.

The **OGYD-EP** type three phase biased bus-bar differential protection and circuit breaker failure protection, based on optical fibre cable links developed by PROTECTA Electronics Co. Ltd. can be used for this aim. Information (currents, voltages, status indications, trips) from the bay units is sent to the central unit via high-speed series lines of optical fibre cable. The central unit performs bus-section-selective protection with independent measuring relays assigned to the actual bus-bar configuration. The central unit evaluates the information, and detects bus-bar faults and the failure of a breaker, and generates backup trip command if it is necessary.

The further SCADA options extend the device to the complex bay unit for the medium voltage network.

Main characteristics

The main characteristics concerning the operation of the bus-bar protection system are as follows:

- one central unit,
- one bay unit for each bays,
- the bay unit can be an ***EuroProt*** type distance protection or an overcurrent protection, which is extended by a "bay module",
- all bay units are interconnected with the central unit via high-speed serial fibre optic cable pair,
- the bay units send to the central unit the following information:
    - the current values of each phases sampled synchronized with 1 ms time steps,
    - presence or absence of the three phase voltages,
    - the status of bus disconnectors of the bay using two bit status signals,
    - starting command for the bay breaker failure protection,
    - signal of the trip command for the circuit breaker in the individual phases;
- the central unit is of numerical type, operating with a main processor (CPU main) and separated digital signal processor (CPU OGYD),
- the central unit sends to the bay units the following information:
    - synchronizing signal with 1 ms time steps,
    - trip command, if needed;
- all currents and binary signals are of three-phase information,
- the central unit determines the bus-bar configuration based on the signals received via fibre optic cable, and assigns measuring elements to the independent bus sections,
- the measuring elements build the sum of the currents (current difference) and calculate the biasing current based on the current magnitudes,
- the decision of the measuring elements is based on the characteristics with a single knee point,
- because of the special decision logic the operation is safe even in case of high grade of CT saturation,
- to issue the trip command the voltage breakdown condition must be fulfilled as well,
- operating time is below 20 ms (see section 7 *Technical data* in detail).
- The breaker failure protection has two steps, the first step generates a new trip command to the own circuit breaker, the second step issues general trip command to all circuit breakers.
- the system can be structured in two versions:
    - centralized structure, when the central unit and the bay units are mounted in a cabinet,
    - decentralized (bay oriented) structure, when the central unit is mounted in a central cabinet, the bay units are located near to the individual bays.

Mode of operation

The bay unit can be an ***EuroProt*** type distance protection or overcurrent protection, which is extended by a driver unit for fibre optic link (OXO). In this configuration this bay module exploits the power supply unit, the integrated input units and the A/D converter of the ***EuroProt*** device. To receive the status signals of the bay disconnectors, the free digital inputs of the device can be applied, or an additional optically isolated binary input module can be inserted in the distance protection or overcurrent protection.

If the bus configuration to be protected contains bus disconnectors as well, the status signals from these devices are to be connected to the central unit.

All bay units are interconnected with the central unit with a high-sped serial line in the form of a pair of fibre optic cable (send and receive). This fibre optic connection is applied in the central configuration as well.

The parameter settings of the protection system is stored in the central unit's CPU MAIN module, the parameter setting process and the communication with the system is controlled by this unit too. The further tasks of this unit are event recording, controlling the auxiliary modules, supervising the signals of the optically isolated input module of the central unit, operating the output relays and running the PROTLOG equation system.

After energizing the unit, and after each parameter modifications the CPU main sends the parameters of the configuration to the CPU OGYD located in the central unit as well. After receipt of these data, the bus-bar differential protection function is performed by the CPU OGYD module alone, the data exchange between the MAIN and OGYD is limited to the status signal connected to the central unit and to the signals indicating the operations.

The bay units send the status signals with two bits (on and off state) of the bay disconnectors in each millisecond via high-speed fibre optic connection to the central unit. Additionally the bay unit sends the information about the presence or absence of the voltages in all three phases, the commands submitted to the bay circuit breakers and breaker failure information received by the bay unit from external sources or generated by the own breaker failure function.

Following the device energizing and after each parameter modifications, all disconnectors are supposed to be disconnected. If there are no changes in the status signals in the subsequent 10 ms then based on the received signals the OGYD performs "configuration", which means determination of the bus-bar lay-out in the substation, and assigns "measuring elements" to each separated bus sections. This process is performed after each changes in the status of all disconnectors, so after 10 ms the protection adapts itself to the new configuration, and the measuring element is reconfigured. In normal operation when receiving faulty status signals from the disconnectors the device keeps the previous state and generates error signals, but supposing the previous bus-bar configurations keeps on operating. If the status error is detected after energizing or following parameter changes, the protection remains

disabled until the faulty status is corrected, and generates "Differential protection disabled" and "Breaker failure disabled" status signals as well.

The central unit sends synchronous signals to each bay units via fibre optic connection, and the bay units answer with sending sampled current values in each phases to the central unit. These values are used by the assigned measuring elements of the central unit. The measuring elements of the central unit perform the following tasks:

- summation of the sampled I_p momentary current values for the bays connected to the bus section:

$$I_{d.p} = \sum I_p$$

- then the current DC component is filtered by subtracting the actual value from that sampled 10 ms before, and the difference is divided by two

$$I_{d.p1} = \frac{I_{d.p} - I_{d.p-10ms}}{2}$$

- the same procedure is repeated with the subsequent sampled value and with the value sampled by 10 ms before that, and the procedure is repeated ten times. These ten calculated values are averaged, receiving the *Id* trip current:

$$Id = \frac{\sum_{n=1}^{10} I_{d.pn}}{10}$$

- additionally to the procedure above from the absolute value of the sampled I_p momentary current values a predetermined (with parameter setting) "a" load vale is subtracted $\left(\left|I_p\right| - a\right)$ (here a=**IOffset** parameter setting, the proposed value of it is the expected maximum load current value of each bay currents). Out of these differences the values above 0 (if $\left(\left|I_p\right| - a\right) > 0$) are summed

$$I_{s.p} = \sum \left(\left|I_p\right| - a\right)$$

- then the average of this value and that received 10 ms before is calculated:

$$I_{s.p1} = \frac{I_{s.p} + I_{s.p-10ms}}{2}$$

- the same procedure is repeated with the subsequent sampled value and with the value sampled by 10 ms before that, and the procedure is repeated ten times. These ten calculated values are averaged, receiving the *Is* biasing current:

$$Is = \frac{\sum_{n=1}^{10} I_{s.pn}}{10}$$

The biasing is calculated by multiplying the *Is* biasing current by a "K" biasing factor (parameter "*Biasing*" which can be set in the range 50% … 80% = 0.5 … 0.8):

$$K * Is = K * \frac{\sum_{n=1}^{10} I_{s.pn}}{10}$$

The bus-bar differential protection operates if:

$$Id \geq K * Is$$

and

$$Id \geq Id\_base$$

The trip characteristic for a measuring element is shown in Fig. 1.

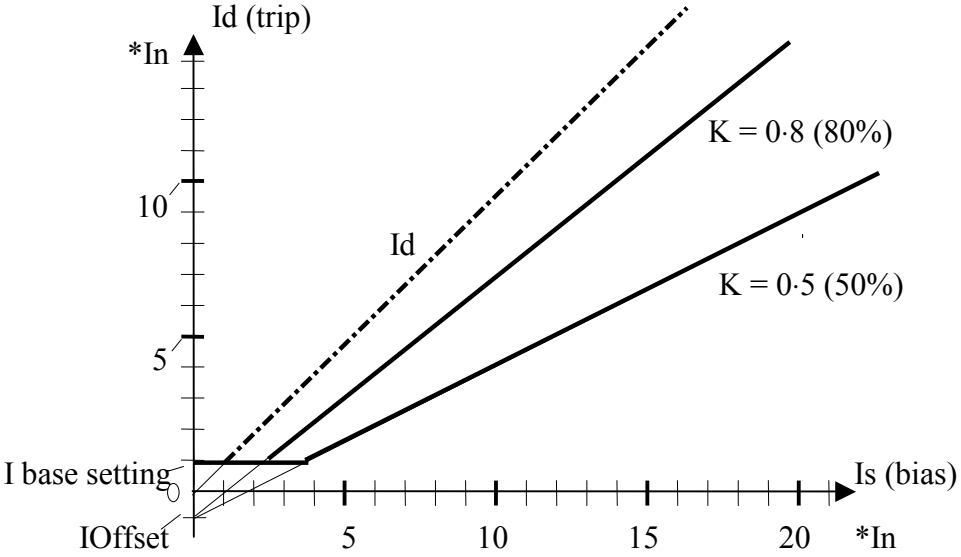

Fig.1 The trip characteristic for a measuring element

Technical data

General technical specification see in **EuroProt system information sheet**
Type tests see in **EuroProt system information sheet**
Design and sizes see in **EuroProt system information sheet**

Busbar protection operating time	
2 x $Id_{basic\ sensitivity}$	30 ms
5 x $Id_{basic\ sensitivity}$	25 ms
50 x $Id_{basic\ sensitivity}$	20 ms
Consumption, basic device	80 mA, 220 V=
for each 3 feeder (each COM3 board)	36 mA, 220 V=
for each digital input	4 mA, 220 V=

Setting ranges

Parameters of the measuring element (primary values):

Basic sensitivity, [I base setting]	50...5000 A, steps 10 A
Biasing (slope), [K]	50...80 %, steps 5 %
Maximum value of feeder load, [I Offset, "a"]	0...5000 A, steps 10 A
CT circuit monitoring failure current, [Iset (CT error)]	10...5000 A, steps 25 A

Parameters of the bays (stored in the central unit):

1st feeder, CT primary rated current, [CTPr A]	50...5000 A, steps 25 A
2nd feeder, CT primary rated current, [CTPr A]	50...5000 A, steps 25 A
…	
nth feeder, CT primary rated current, [CTPr A]	50...5000 A, steps 25 A

Timer parameters:

CT circuit monitoring timer, operating and drop-out delay, [CT error delay]	100...32000 ms, steps: 10 ms
CB failure protection, 1st timer (BF timer 1)	0...32000 ms, steps 10 ms
CB failure protection, 2nd timer (BF timer 2)	0...32000 ms, steps 10 ms
Disconnect switch disagreement protection timer (Disc.status error timer)	1...60 s, steps 1 s

Voltage relay parameters:

Feeder voltage checks (Bay voltage condition)	0,7.Un, *fixed value*

Ordering information

On ordering the ***OGYD-EP*** bus-bar protection and breaker failure protection, the following data have to be given:

- the DC supply voltage value,
- the primary disposition of the protected bus-bar (with CB's, disconnecor switches, location of the measuring transformers),
- maximum fault current,
- minimum CT primary rated current, and the related accuracy limit factor of CT-s,
- the requested design of the bus-bar protection (centralized, decentralized),
- mounting version form of the protection.

On ordering, it is advised to consult with the experts of PROTECTA Electronics Co. Ltd.