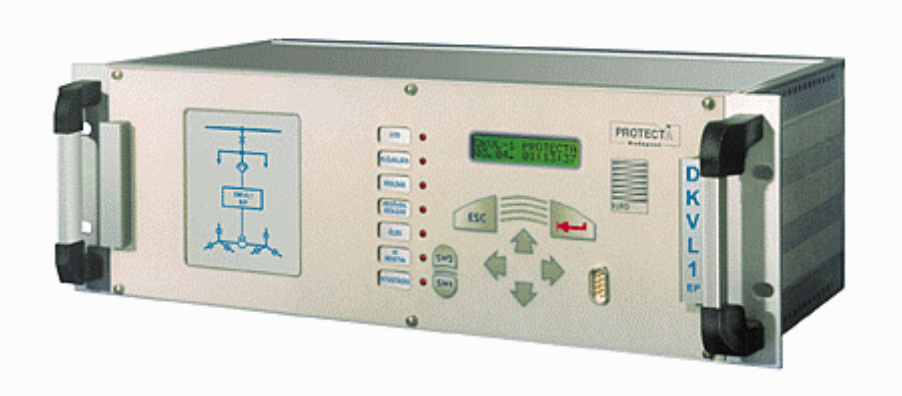
DKVL1-EP

DIGITAL CAPACITOR BANK PROTECTION AND FAULT LOCATOR



Field of application

The ***EuroProt*** type complex protection in respect of hardware and software is a modular device. The modules are assembled and configured according to the requirements, then the functions are determined - within the hardware limitations - by the software. This document describes the individual characteristics of a specific application: the factory configuration ***DKVL1-EP*** capacitor bank protection. The general description of the members of the ***EuroProt*** type complex protection family can be found in document "***EuroProt*** complex protection, hardware and software description and user's manual" (further "*EuroProt manual*").

The ***DKVL1-EP*** digital capacitor bank protection of PROTECTA Co. Ltd. is designed to protect star connected capacitor banks divided in two parts. It is connected to the line-to-line voltage of the discharge voltage transformer, and to the voltage transformer between the two star points. The application of the same type of voltage transformers is advisable. The design supposes isolated type on both ends, with the given turns ratio of rated line voltage / 100 V, if it is not ordered otherwise. In this application in case of rated network voltage the secondary line-to-line voltage is 100 V. In case of short-circuit of one half bank the voltage difference is $100/\sqrt{3}$ V. As the device gets the line-to-line voltage of the discharge voltage transformer, its primary star point can be grounded as well. The displayed voltages of the protection are given as percentage of this secondary rated voltage, which is 100 V in case of line-to-line voltage, and in case of full single phase short-circuit of one half bank the voltage difference is the phase voltage.

As an option the included control (SCADA) functions can extend the device to the complex field unit of the medium voltage network.

Main characteristics

Overvoltage function:

- Definite time signalling stage with own time delay setting,
- Voltage dependent characteristics of the tripping stage with own time delay,
- Fault locator, identifying the faulty half bank and the concerned phase,
- Breaker failure protection,
- Interactive compensation of the operating voltage asymmetry.

Working principle

The ***DKVL1-EP*** device is a fully microprocessor based construction, the functions and their versions are realised basically with software.

THE PROTECTION

In case of internal fault inside the capacitor bank the voltage difference measured between the star points changes.

The protection involves a signalling stage and a tripping stage. The tripping stage starts a second timer as well, which - in case of breaker failure - disconnects the circuit breaker feeding the bus-bar.

The setting of the signalling stage is suitable, if the fault of one capacitor unit can be detected. In case of smaller units there is possibility to select a setting, which detects the break of connection of one unit as well.

In case of larger capacitor banks the user has a great interest to operate the bank as long as possible in energised state. The healthy units however must be protected against voltages higher than the normal value, so the precondition of tripping is if the voltage of the highest stressed healthy unit is above the allowed limit. This depends on the actual voltage, on the type and extension of the fault. In case of low network voltage a higher percentage of faulty elements is allowed without the endangering the other healthy units. The tripping stage must have a voltage dependent tripping characteristics.

According to these facts the healthy capacitor units are overloaded, if without faulty elements the voltage itself is above the allowed limit. In this case tripping would be needed. A practical requirement is however, that the capacitor bank protection should operate only, if there is fault inside the bank. So the characteristic of the protection is limited: if the asymmetry is less than a set value, no trip command is issued. It is obvious, if a fix relay operating value is required then the allowed voltage setting should be less than the normal network voltage. With this setting the protection operates in the fix section of the characteristics.

FAULT LOCATOR

The fault locator helps finding the faulty element after tripping by the protection, identifying the faulty half bank and the faulty phase. The locator determines the phase angle of the voltage difference, and based on this value the fault location can be identified. As for example the short-circuit in phase R results the same fault voltage, then open conductor in R phase of the other half bank, it is not possible to make difference between these two states. The protection should be connected according to the most probable fault type. In case of internal fuses the open state is more probable, because a short-circuit will result open conductor if the internal fuse melts.

The locator operates in case of warning signal and in case of trip command as well. The fault location is calculated 80 ms after the operation of the protection, the displaying and the event logging is performed however at the same time, as closing the warning or tripping contact. In this way the displaying by the locator in case of transient faults does not disturb the operator if no other event happens.

The locator calculates the vector location of the voltage difference comparing to he ST line voltage, and to a vector, which is between R phase and the middle point of ST line voltage, perpendicular to ST voltage, scaled to line voltage size. The angle measurement is performed only if the voltage is above 50% Un, to avoid errors in fault location caused by missing or too low voltage in case of signalling or tripping.

Using the on-line display of a computer, beside the bits identifying the warning and tripped states of the individual stages the result of fault location is displayed as well. This is valid, until the measuring element is in active state. In the event menu of the display on the device it can be displayed only if the event is over, and the function is dropped off.

THE PROCEDURE OF COMPENSATION

Because of the capacitance deviations of individual capacitors in the assembled banks, there is always a certain asymmetry present. As in certain cases it can be above the minimum set level of the warning stage, and the correct operation of the fault locator would be impossible as well, this natural asymmetry must be compensated. This can be carried out with the parameter setting menu. In this case the protection measures the natural voltage difference, and it can be compensated to zero value by adding two perpendicular vectors of appropriate value. All subsequent changes will be measured referencing this compensated vector value. The 50% voltage limit is valid here as well; below this value no compensation is possible. If the user tries to do it, the program gets to the unsuccessfully compensated state, and the compensation of the previous successful attempt remains. The compensated state can be switched off; in this case using the "Test" menu the display shows the measured voltage difference.

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**

Setting ranges	
Setting of the warning stage	4 …100 ‰, step 2‰
Setting value of the constant section of the tripping stage	4 …100 ‰, step 2‰
Slope code of the tripping characteristics	0 …10, step 1 (in case of 0 the slope is 0.7)
Allowed voltage limit of the capacitor bank, related to the secondary rated voltage	90 …130 %, step 2 %
Time delay of the warning stage	0.2 … 10 s, step 0.1 s
Time delay of the tripping stage	0.2 … 10 s, step 0.1 s
Time delay of the backup stage	0.2 … 10 s, step 0.1 s

Options

The device can be extended by optional units:

- SCADA connection (see *EuroProt* system information sheet),
- output relays with 4 A breaking capability.

Ordering information

- Protection type [DKVL1-EP],
- Protection case type [19" cabinet frame mounted device, or panel mounted device
- Rated voltage [100 V, 200 V],
- Output relay contact type [NC or NO, if deviates from the *Technical Data*],
- Options if needed