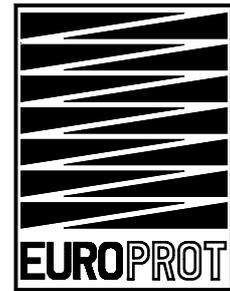


DTRV-EP

COMPLEX DIGITAL PROTECTION FOR 120 kV / MEDIUM VOLTAGE TRANSFORMERS



Application field

The DTRV type of complex transformer protection is designed to protect 120 kV / medium voltage transformers, and to perform automatic regulation and control tasks. All usual transformer protection functions (differential protection, phase and earth fault protection, overload protection, breaker failure protection and other backup protection) are realised, including all control functions and some regulation functions as well. The intelligent programmable tripping matrix scheme offers high level of flexibility for engineering and operation. The full or partially independent operation of its individual functions and the integrated self-checking system increases reliability of the protection system. Because of the different voltage levels at the medium voltage side - combined with different neutral grounding practice of the medium voltage networks - and the structure of the transformers with secondary and tertiary windings, and additionally the many possible substation configurations and number of parallel transformers for one voltage level, there are many variations and combinations of the protection functions. (Accordingly this short description intends only to attract attention to this product of PROTECTA Ltd.)

Main characteristics

- The complex protection system provides all protection and control functions needed for transformers.
- It has distributed structure, which means for example, that a complex protection is constructed of several independent units, separately supplied and individually housed:
 - DTD-EP+ (DTRV-EP1) multi-functional differential protection,
 - DTRV-EP2 containing mostly the high voltage side protection functions,
 - DTRV-EP3 for medium voltage side functions, and
 - DTSZ2-HA-EP type automatic voltage regulator;
- Main functions of DTD2-EP (DTRV-EP1) numerical differential protection are:
 - Collection of trip signals from the mechanical type transformer protection,
 - Transformer differential protection,
 - Overcurrent protection for the 120 kV side.
 - Overcurrent protection for the medium voltage side;
- DTRV-EP2 digital device serves mainly the 120 kV side:
 - Collection of trip signals from the mechanical type transformer protection,
 - Two stage definite time overcurrent protection for the 120 kV side,
 - Protection against breaker discrepancy,
 - Starting the 120 kV breaker failure protection,
 - Collection of trip signal from the auxiliary 120 kV bus-bar protection and breaker failure protection,
 - Collection of ON and OFF commands from auxiliary event driven switch-over relay (called ETRA),
 - Collection of manual ON and OFF commands,
 - Overcurrent protection for the auxiliary neutral grounding transformer,
 - Self-checking functions, supervision of the 120 kV circuit breaker command circuits, current transformer circuits, 20 kV status signal errors, power supply errors, EEPROM failures, power supply disturbances, DSP errors;
- The functions of DTRV-EP3 digital device serve mainly the 20 kV side:
 - Two stage definite time overcurrent protection,
 - Logic type bus-bar protection,
 - Dead zone protection,
 - Breaker failure protection for the transformer,
 - Breaker failure protection for the circuit breakers in the bays,
 - Automatic reclosing function,
 - Two stage definite time zero sequence overcurrent protection, for the neutral resistor (which increases the ground fault current to a detectable level),
 - Oil temperature protection for the FANOE neutral resistor, and its breaker failure protection,
 - Automatic controller for the neutral resistor switching (called FAVA in the Hungarian power system),
 - $U_0 >$ relay,
 - Possible mode of operation in case of live line working,
 - Comprehensive self-supervision and monitoring of CB operating circuit, 20 kV status signals, current transformer circuit supervision for the 20 kV side, EEPROM failures, power supply disturbances, DSP errors;

- Optionally for 10 kV secondary voltage level:
 - Two stage definite time overcurrent protection,
 - Backup impedance protection with three zones in forward direction and one in reverse direction, individual timers for all stages,
 - Logic type bus-bar protection,
 - Dead zone protection,
 - Breaker failure protection for the transformer,
 - Breaker failure protection for the circuit breakers in the bays,
 - Automatic reclosing function,
 - Two stage zero sequence definite time overcurrent protection, supplied by the FANOE resistor (oil isolated resistor for increasing the ground fault current to a detectable level),
 - Two phase overcurrent protection for the auxiliary neutral grounding transformer,
 - $U_0 >$ relay,
 - Supervision of the Circuit of logic bus-bar protection,
 - Comprehensive self-supervision and monitoring of CB operating circuit, 10 kV status signals, current transformer circuit supervision for the 10 kV side, EEPROM failures, power supply disturbances, DSP errors;
- Intelligent trip matrix in all of the devices mentioned above. In this way all protection functions can be enabled or disabled, and the commands can be directed to the appropriate output relay,
- The rows of the trip matrix can be disabled individually,
- The signals received via optical-coupler inputs by the devices EP2 and EP3 can be enabled or disabled by bit parameters,
- The advantage of the distributed structure is, that in case of failure of one device the others may remain in operation,
- The distributed structure offers backup protection scheme,
- The distributed structure supports easy tests of the relay functions.

Principle of operation

The principle of operation of the units in a typical DTRV complex protection:

- **DTD2-EP (DTRV-EP1) digital differential protection**
 - The differential protection for the transformer is performed by a DTD2-EP type digital transformer differential protection.
 - The protection is not sensitive to the inrush current of the transformer. The operating time is 25-30 ms, in case of starting the high-set current stage about 15...20 ms. The protection contains an intelligent trip matrix, so the trip command can be directed to the appropriate output relays.
 - The DTD2 type transformer differential protection performs the protection functions needed for a transformer, independent of the other units, so the racks of the cabinet can be considered as backup protection for each other.
 - The protection collects the signals of the mechanical protection of the transformer. There is an overcurrent protection configured for the 120 kV and medium voltage side, which is single stage in DTD2-EP for 120 kV, and two stages for the medium voltage level. In this way the appropriate reserve backup protection is provided.

- **Operation of DTRV-EP2 complex digital transformer protection**

- The device contains a two stages definite time overcurrent protection for the 120 kV side,
- In case of transformers supplied by a radial line, the phase selective protection and automatic reclosing function is included as well,
- The protection against breaker discrepancy protects against single- or two-phase operation if the 120 kV circuit breakers operated individually in the phases.
- It starts the 120 kV breaker failure protection, and collects the trip signals from the 120 kV bus-bar protection and from the 120 kV breaker failure protection.
- With an independent contact it gives command to the auxiliary ETRA automatic controller,
- Collects the trip and closing command from ETRA, and if the preconditions are fulfilled, they are passed to the CB.
- Collects manual ON and OFF commands,
- The device contains the two-phase overcurrent protection function for the neutral grounding transformer (in phases R and T).
- This device collects the signals of the mechanical protection of the transformer as well (Two Buchholz (gas) relays, oil temperature and winding temperature protection, over-pressure protection for the transformer tap changer, protection for the neutral grounding transformer, and for the Petersen coil).

- **Operation of DTRV-EP3 complex digital transformer protection in case of 20kV version**

- The first stage ($I >> t$) of the definite time overcurrent protection for the 20 kV side in the device protects the bus-bar and the connected power elements.
- The logic bus-bar protection provides selective and quick protection for the individual bus-bar sections.
- In case of failures of the circuit breaker in the bays the breaker failure protection function in DTRV trips the CB supplying the fault.
- The second, low current setting stage ($I > t$) of the definite time overcurrent protection for the 20 kV side provides remote backup protection for the bays.
- The dead zone protection function of the device for the 20 kV side gives trip command in case of faults between the current transformer and the CB.
- The 20 kV transformer breaker failure protection trips the 120 kV circuit breaker, in case the 20 kV CB fails to trip, because of the failure of the operating circuit or of the CB itself.
- The high set stage of the zero sequence definite time overcurrent protection - connected to the current transformer of the resistor for increasing the earth-fault current has two time stages The first stage serves as remote backup protection for the 20 kV bays, the second stage is the back-up protection for the transformer and the bus-bar.
- The second stage of the zero sequence low set overcurrent protection of the neutral resistor gives an enabling signal in case of live line working to the "LLW" circuit.
- The zero sequence $U_0 >$ overvoltage function controls the operation of neutral resistor automatics, and in case of live line working it starts the $t_{U_0 >}$ time measurement, and serves in all modes of operation as backup protection.
- This device contains the temperature logic and the breaker failure protection for the neutral resistor.

- This device contains the automatic control function of the resistor for increasing the earth-fault current. This automatic function is controlled by the zero sequence overvoltage function ($U_0 >$), supplied by the voltage transformer connected to the 20 kV side of the transformer.
- The operation of the 20 kV single shot reclosing controller is initiated by external or internal signals. According to the primary structure, the device can operate one or two circuit breakers.

- **Operation of DTRV-EP3 complex digital transformer protection in case of 10kV version**

- The first stage ($I >> t$) of the definite time overcurrent protection for the 10 kV side in the device protects the bus-bar and the connected power elements.
- The logic bus-bar protection controls the operation of the 10 kV under-impedance protection.
- This device contains the overcurrent function for the neutral grounding transformer. This protection is connected to two phases (R, T).
- The device contains a four stages of under-impedance protection, with independent time setting for each stages. Three of them are directed forwards and one in reverse direction (toward the transformer).
- The dead zone protection function of the device for the 10 kV side gives trip command in case of faults between the current transformer and the CB.
- The 10 kV transformer breaker failure protection trips the 120 kV circuit breaker, in case the 10 kV CB fails to trip, because of the failure of the operating circuit or of the CB itself.
- The two stages of the zero sequence definite time overcurrent protection - connected to the current transformer of the resistor for increasing the earth-fault current - protect the 10 kV bus-bar as main protection in case of earth faults, and serves as backup earth fault protection for the bays.
- There is a zero sequence overvoltage function in the device for signalling earth faults, which calculates the zero sequence voltage based on the phase voltages of the 10 kV voltage transformers. This function has a signalling role only.
- The 10 kV breaker failure protection function of this device trips the circuit breaker supplying the short-circuit, if the 10 kV bay circuit breaker fails to trip.
- The basic version of the single shot automatic 10 kV reclosing function can handle selectively both 10 kV CB-s connecting two independent bus-bar sections of the same voltage level.

Design

The DTRV-EP complex protection equipment is delivered in a steel-sheet cabinet with standard 19” hinged rack system and locked door, accessible from the front side. When selecting the cabinet type the manufacturer can consider the special requirements of the user. If not specified at ordering, the cabinet is of RITTAL PS type.

Options

As option the device can be extended with the following units:

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

Ordering information

When ordering the experts of PROTECTA are ready for consultation and for the necessary engineering activity.