DTR-EP

COMPLEX DIGITAL TRANSFORMER PROTECTION FOR MEDIUM VOLTAGE NETWORKS

The complex digital transformer protection for medium voltage networks of type **DTR-EP** is part of device family named *EuroProt* . This short description contains special data of this type. General and common features of *EuroProt* family can be found in the *EuroProt* system information sheet. Accordingly it is proposed to study both this short description and system information sheet too, in order to understand the device entirely.

Application field

The ***DTR-EP*** type complex digital transformer protection of PROTECTA Co. Ltd. is designed to perform all protection functions of medium voltage / 0.4 kV auxiliary dry type or oil insulated transformers, applied in power plants and in industrial plants. It contains phase and earth fault protection, overload protection, reserve protection for the transformer and circuit breaker protection.

Main characteristics

- contains all necessary protection functions,
- for phase fault protection it realises two phase, two stage overcurrent protection, consisting of a high current set high speed stage and a low current set delayed stage.
- the setting of the high set current stage does not reach over the transformer,
- the delayed stage is a positive and negative sequence voltage polarised overcurrent protection, the setting of which must assure that the protection reaches over the transformer,
- for earth fault protection a directional, zero sequence overcurrent function is provided,
- the earth fault directional characteristics have two characteristic angles to be set independently, and has a reset hysteresis.
- the overload protection is an overcurrent protection with long time delay,
- the complex protection handles the external Buchholz (gas) protection of oil insulated transformers,
- an independent two phase, self-powered, reserve protection (KZT) is added to the numerical part,
- the device has 14 output contacts (11 NO and 3 NC contacts), 3 of them is fix (1 NC for self test and two NO for trip initiated by the reserve protection) 11 contacts can be freely assigned with the software matrix,
- the protection is microprocessor controlled with the exception of reserve protection and voltage relays, the handling is performed with the help of a menu system,
- the automatics contain continuous self-check functions.

Software characteristics:

- built-in self-check functions,
- digital event recorder for 50 events, and an event sequence recorder with 1 ms time resolution for maximum 300 events,
- analog event records with current data,
- two additional timers (T1 and T2) in connection with the software matrix,
- the rows of the matrix (the relay-functions) can be latched.

Hardware characteristics:

- numerical type, with own A/D converter, digital signal processor (DSP) and separate main processor,
- 8 opto-coupler inputs,
- 14 output contacts,
- the type of the contacts (NC or NO) can be selected individually for each contacts when ordering,
- versions for 19" rack cabinet mounting or housed in relay case (semi-flush mounting or hinged type).

Communication:

- 2x16 character LCD display for setting the functions, dispalying messages and reading event records,
- on-line screen on external PC to make commissioning and testing easier,
- external communication interface, can be set for RS 232 or for fibre optic cable,
- optional interface module for SCADA systems,
- the set parameters can be saved and downloaded,
- real time clock handling with the aid of RAM with battery, (which can be synchronised via optical fibre cable connected to external PC, to the SCADA system, or through an optical cable).

Working principle

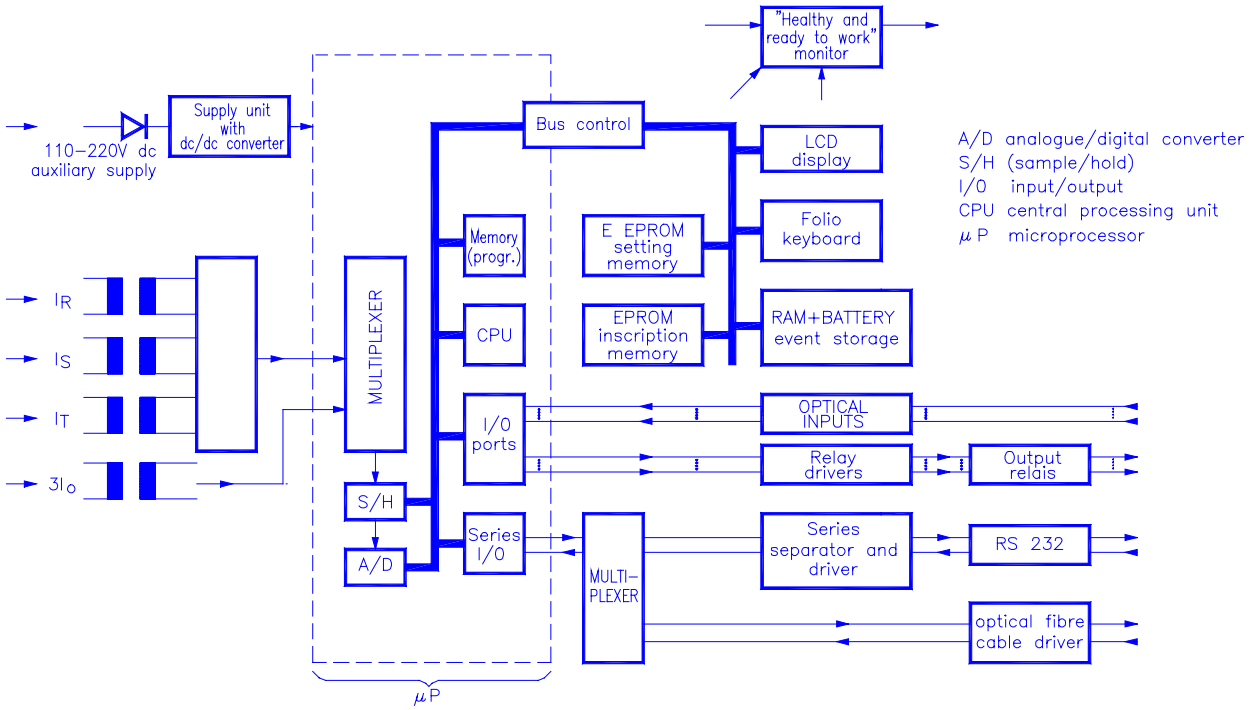
The scheme of working principle of DTR-EP complex protection is shown on the following Figure.

The device is a fully microprocessor based construction, the functions and their versions are realised basically on software.

The device contains a 87C196 type 16 bit micro-controller. The program is stored in the internal EPROM of the controller, the message text for the display is stored in EPROM as well. The parameter setting is loaded in EEPROM. Events are recorded in battery supplied RAM. The man-machine interface consists of a keyboard with six push-buttons, above it the two row, 2 x 16 character LCD display, seven LEDs and two SW pushbuttons.

There is possibility for external communication via the RS 232 interface, located on the front panel, or via the fibre optic cable interface on the lower case side beside terminal block. Selection between the RS232 or the fibre optic is performed by parameter.

The protection contains real time clock with battery supplied RAM, synchronised via PC or through opto-coupler input (month, day, hour, minute). The external PC displays year as well.



Scheme of the digital system

The analog current inputs are connected via inductive internal measuring transformers and low-pass filters to the multiplexer then to the A/D converter, where all phase currents and the zero sequence current signals are sampled in every 0,5 ms. All overcurrent stages are applied for each input current.

The protection contains the following overcurrent stages:

- two phase definite time high current set overcurrent stage (I>>),
- two phase definite time voltage polarised low current set overcurrent stage(I>),
- zero sequence, directional, definite time overcurrent function ($3I_0$>),
- two phase definite time low current set overload stage (I>Overload),
- autonomous, self-powered definite time, voltage polarised overcurrent reserve protection.

The setting of the high set, high speed overcurrent function must assure that the protection does not reach over the transformer.

The low set short-circuit overcurrent protection is a positive and negative sequence, 0.4 kV polarised overcurrent protection. The timer of this function starts, if the positive sequence voltage drops, or

there is negative sequence voltage component, and at the same time the overcurrent function starts as well. The setting must assure that the protection reaches over the transformer.

[(I>$_R$+I>$_T$).(U$_2$>+U$_1$<) . t].

The earth fault protection is a directional, zero sequence, definite time overcurrent protection *[3I$_0$> . φ. t]*. Both characteristic angles of the directional lines can be set independently and as it is required, and has a reset hysteresis as well. To the directional measurement the zero sequence voltage is measured as the secondary residual voltage of the medium voltage level voltage transformers.

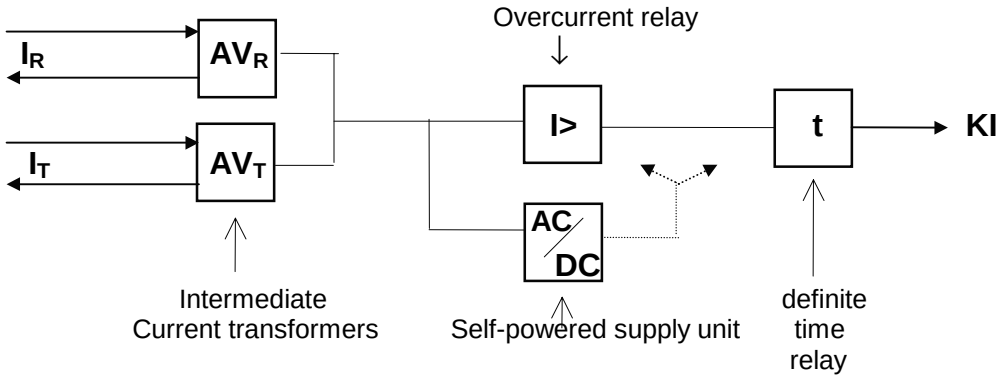
The overload protection is an overcurrent protection with long set time delay.

The complex protection handles the external Bucholz (gas) protection of the oil isolated transformers. It accepts the starting signal only if it is at least 12 ms long, and when receiving the trip impulse, the signal is latched until the acknowledgement in the operation menu.

The autonomous, self-powered, two phase, definite time reserve overcurrent relay (KZT) operates independently of the digital part. In normal operation it is blocked by positive and negative sequence 0.4 kV components so that at submission of the trip command it takes into account the signals of the non-digital voltage module. If the DC voltage supplying the protection fails, then in case of operation of the reserve protection it closes the own trip contacts without voltage checking.

The device contains continuous and periodic self-checking and monitoring function. The continuous checking measures the presence of the supply voltage as well. The periodic checking starts at the preset time, and it can be started directly with the help of the menu system. Both systems are described in details in the ***DKU*** manual. Both self-checking system gives alarm signal in case of the detected failure, the red LED at the display is powered, and the LDC automatically displays an error message.

The built-in reserve protection of the DTR-EP complex protection is a ***KZT*** type self-powered autonomous overcurrent protection. This protection is located in an independent plug-in module of the DTR-EP device. This protection is a classic electronic protection designed with IC technology. Its rated current is fix, and is the same, as that of the DTR-EP protection. There may be deviation when ordering. This device contains three induction type intermediate current transformers. The secondary side of them supplies partly the power consumption of the protection itself with an AC/DC power supply unit, and they feed the electronics of the overcurrent relays (I>) and the timers (t).



The scheme of the reserve protection

Technical data

Rated secondary current, I_n	1A or 5 A
Rated voltage (line), U_n	100V or 200 V
Rated frequency	50 Hz or 60 Hz
Overload capacity, voltage circuit, thermal, continuous	$2xU_{phase}=2xU_n/\sqrt{3}$
current circuit, thermal, continuous	$4xI_n$

1 s	$100xI_n$ (if I_n = 1 A) $50xI_n$ (if I_n = 5 A)
Dynamic current limit	$100xI_n$
Accuracy, current relays (above 50 % I_n)	±2 %
Accuracy timers, with 10 ms steps with 1 s steps	±3 ms ±12 ms
Reset ratio, current relays	95 %
Number of output relays	12 print relays
Type of contacts (NO / NC):	*to be selected at ordering, factory setting 1 NC 11 NO*
Output contacts, electrical data: rated switching voltage continuous load current making current DC breaking capability at 220 V, at pure conductive load at load of L/R = 40 ms *option* at load of L/R = 40 ms	 250 V 8 A 16 A 0,25 A 0,14 A 4 A
Auxiliary DC voltage (the same supply unit) voltage tolerance	220 V or 110 V 88...310 V
Permissible ambient temperature	0° ...50° C
Insulation test (IEC 255)	2 kV, 50 Hz 5 kV, 1,2/50 µs
Disturbance test (IEC 255)	2,5 kV, 1 MHz
Electrostatic discharge (ESD, IEC 801-2)	8 kV
Burst test (IEC 801-4)	2 kV
Setting ranges	
Positive sequence voltage relays	(0.1 …0.8) U_n, step 0.1 U_n
Negative sequence voltage relays	(0.1 …0.45) U_n, step 0.05 U_n
High set short-circuit overcurrent setting (I>>/I_n)	250 …2500 %, step 5%
Low set short-circuit overcurrent setting (I>/I_n)	50 …450 %, step 5%
Zero sequence setting (3Io>/I_n)	10 – 104 %, step 2 %
Application of core balance CT (3Io>/I_n)	10 – 104 ‰, step 2 ‰
Time delay, high set short-circuit overcurrent prot. t (I>>)	0…1000 ms, step: 10 ms
Time delay, low set short-circuit overcurrent prot. t (I>)	0 ...10000 ms, step: 50 ms
Time delay, zero sequence overcurrent prot. t (3Io>)	0... 10000 ms, step: 50 ms
Time delay, overload prot. t (overload)	0...50000 ms, step: 50 ms
Time delay, reserve prot. t (reserve)	0...10000 ms, step: 100 ms
Time delay, breaker failure prot. t (BF)	0...1000 ms, step: 50 ms
Healthy-to-work failure signal timer t[fail]	0...100 s, step: 1 s
Time delay, T1 additional timer t (Mxs T1)	0...50000 ms, step: 50 ms
Time delay, T2 additional timer t (Mxs T2)	0...50000 ms, step: 50 ms
CT rated primary current, In[AV]	50...1250 A, step: 50 A
External communication type	RS 232 or fibre optic cable
Serial communication Baud rate	150...19200 Baud
Optical fibre cable operation mode	Radial or loop
Daily automatic self-check time	23 hours 59 min.(step 1 min)
Automatic self-check block	setting 60 min

Design, size

An ***EuroProt*** device is always rack mounted, it has two design forms. One of the form is suitable to be mounted into standard 19" cabinet frame, this form is also suitable to be mounted directly to a relay panel with flash mounted form. The other form is a relay panel mounted device with raised-hinged form.

Outline size of *19"cabinet frame mounted device*:

Width	Height	Depth
483 mm	132,5 mm	201 mm

Outline of the *panel mounted device with raised-hinged form*:

Width	Height	Depth
490 mm	250 mm	250 mm

Weight: 8 kg.

Options

The device can be extended by optional units:

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

Information required with order

- Protection type [DTRV-EP],
- Protection case type [19" cabinet frame mounted device, or panel mounted device
- Rated current [1 A, 5 A],
- Rated voltage [100 V, 200 V],
- Output relay contact type [NC or NO, if deviates from the *Technical Data*],
- Options if needed

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