TRIMx-EP

DIGITAL TRANSFORMER INRUSH CURRENT MINIMISER

Application field

TRIM3-EP digital device has been specially designed for minimising the inrush current in three-phase power transformers. The device measures the voltage on the transformer and determines the residual flux after switching off the transformer. The next energising is synchronised to the voltage on the supply side of the circuit breaker. The optimal moment of closing the contact is calculated based on the residual flux values in the iron cores of the transformer. The closing command is issued according to the measured operation time of the circuit breaker, which is set as a parameter.

The version ***TRIM1-EP*** is specially designed for singe phase power transformers in railway traction.

The version ***TRIM3-EP*** controls energising of three-phase transformers. It is designed to issue synchronised "ON" commands for circuit breakers with individual drives in each phases, or for circuit breakers with common drive for all phases. In case of this latter mechanically delayed drives the switching delay can be 5 – 0 – 5 ms or 0 – 6.66 - 3.33 ms. This controlled energising can assure even in case of the less effective common drives, that the largest inrush current peak value will be less than the rated current peak value.

The control algorithm can be programmed in a stand-alone device, or can be a function of a complex numerical protection. The illustration above shows transformer differential protection extended with TRIM function.

Method of Operation

The method of operation is explained with Fig.1 :

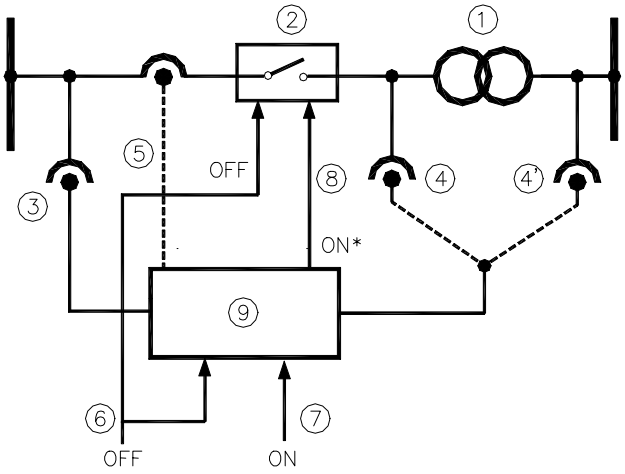

Fig. 1. Method of operation

The device (9) minimises the inrush current of (single or three-phase) transformer (1) by synchronised energising command to the circuit breaker (2). The moment of closing the contacts of the circuit breaker is synchronised to the positive zero crossing of the signal from the voltage transformer (3). To determine the appropriate moment of closing the contacts of the circuit breaker, the values of the "residual flux" in the iron cores of the transformer are needed. The residual flux can be determined with the integration of the voltage signal from the voltage transformer (4), which can be on the primary or secondary (or tertiary) side of the transformer. This voltage transformer must measure the decaying voltage after the OFF command (6) disconnects the transformer. When the measured voltage on the transformer decays to zero, the calculated residual flux values are stored in the memory of the device. The optimal moment of closing the circuit breaker (or the optimal moments in case of individual drives for the three phases) is calculated with the aim, that after energising the flux-time function could continue as a stationary function. In this case the flux can not reach the saturation value, and no inrush current can arise.

If input (7) of the device receives the intent to energise the transformer, then the output (8) delivers the synchronised common or individual ON* command to the phases of the circuit breaker.

In case of normal three-phase transformers, for the correct operation of the algorithm it is sufficient to measure the voltage in two phases from the voltage transformer (4), and the voltage transformer (3) may deliver a single phase signal only.

To measure the current signals from the current transformer (5) is an option only, it is not necessary for the operation of the algorithm, but during the commissioning the collected peak current display is useful information to check the correct operation of the device.

To assure optimal efficiency in minimising the inrush current peak value, the requirement is, that the deviation of the circuit breaker closing time does not exceed ±2 ms.

Main Features

- Transformer inrush current minimiser can be an independent device or can be a function in a complex transformer protection equipment.
- Control of circuit breakers with three independent drives. In this case the inrush current remains in the range of the normal magnetising current.
- Control of circuit breakers with a common drive of mechanical time-delay of the individual phases. In this case the absolute minimum of the inrush current can not be guarantied, but the inrush current remains below the rated current of the transformer.
- Possibility to measure voltages on the primary or on the secondary side of the transformer.
- Easy parameter setting.
- Easy commissioning.
- Built-in self test function with dc supply check, trip/close circuit supervision and Watch Dog.
- One serial communication direction with two ports: (selectable with a parameter)
  - an isolated RS 232 connector on the front plate
  - a fibre-optic connector on the rear plate.
- Two types of event recording:
  - event log for storing collected data of the last 50 protection operations
  - event sequence recorder with 1 ms resolution for 300 events.
- 16 isolated optical coupled binary inputs.
- 8 output contacts with user-defined functions. Each can be NO or NC.
- 6 indicating LEDs.
- Man-machine communication via external PC or built-in LCD display.,
- Battery backed-up RAM to store events and running real time clock.
- Clock synchronisation with external binary input or on serial link.

Commissioning

Commissioning of the device is an easy procedure. The first energising of the transformer is uncontrolled, but the program measures the circuit breaker operating time. This operating time is an input parameter as well, which must be set correctly, according to the measured and displayed value.
During the next OFF switching, the device determines the residual flux values, and the subsequent ON commands are synchronised, without high inrush current peak values.
The integrated event recorder function stores the measured circuit breaker operating time for several events, which can be a basis for a subsequent parameter correction.
If the current measuring option is included, the event recorder stores the measured current peak values for evaluation.
An additional option can be an integrated disturbance recorder function, which enables the detailed analysis of the transformer energising and disconnecting phenomena.

Optional Functions

- Digital fault recorder with 80 sec recording time.
- RTU card with IEC 870-5-101, 870-5-103, MODBUS protocols and complete RTU functions.
- Additional binary input and output contact cards for RTU tasks.
- Graphic LCD display (320x240 pixels) on front plate for displaying measured values and one-line scheme.
- Current inputs
- Automatic selection of measured VT signals (Fig.2)

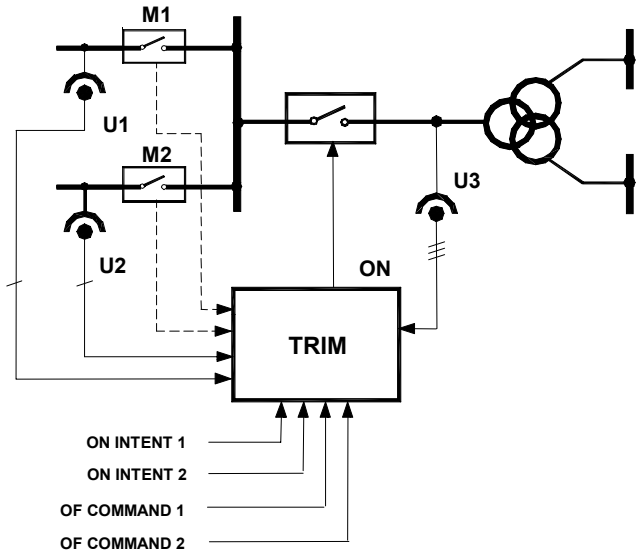

Fig 2. Application with measured voltage selection

Technical specification

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

CB ON operating time	10 to 1000, step 1 ms
Maximal trip time	10 to 300, step 10 ms
CB ON impulse time	10 to 500, step 10 ms
Synchron switching enable	Yes/No
5-0-5 ms mechanical time delay	Yes/No
Delta secondary	Yes/No