Technology

E 3.4.6

Protective Relays Advanced

Notes

Note on EMC

The sensitive electronics of the equipment contained in the present experiment literature can be impaired due to the discharge of static electricity. Consequently, electrostatic build up should be avoided (particularly by utilizing appropriate rooms) or eliminated by discharging (e.g. at the panel frames or similar).

Experiments

The book eventually contains experiments with devices, which are not included in the delivery. Applicable in this case are only those experiments, for which LD delivered the required material. Further requirements of any kind, particularly indemnity requirements on the base of this manual, are excluded. Additional experiments deviating from the procedures described here are possible by qualified persons considering the local security

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1.2 Experiment procedure

1.2.1 Description of the transformer differential protective relay

Fig. 16: Transformer differential protective relay

The primary side of the transformer under protection should be connected to TRANSFORMER PRIMARY (1S2 to 3S2), the secondary side to TRANSFORMER SECONDARY (5S1 to 7S1). Three phase voltage supply for the primary side can be connected to 1L1, 1L2 and 1L3 (1S1 to 3S1), the load is to be connected to 2L1, 2L2 and 2L3 (5S2 to 7S2).

The nominal current on each phase is 1 A, whereby a continuous overload up to 4 A is possible. For the differential protection to operate correctly, the phase sequence of the voltages must generate a clockwise rotating field. The power consumption of the measurement inputs (also known as the burden) is less than 0.1 VA at the rated current. The relay can be used in a frequency range of 50 Hz – 60 Hz.

For operation, the relay requires an external power supply on terminals A1 - A2. The built-in long-range power supply allows for this either a DC voltage of 24 V to 270 V or an AC voltage of 48 V to 230 V.

After bootup, the functional readiness of the relay is displayed by the green SYSTEM LED.

The unit can be operated entirely via the user interface on the front panel. All functions are described in the operating instructions of the unit. However, we recommend performing the parameterisation and control of the device with the provided software *Smart view* and describe this way in the experiments. For the installation of the software, please refer to the manufacturer's operating instructions. We recommend an USB connection from the PC to the device.

A tripping of the relay is indicated by LED and with the output relays K1 and K2 (terminals 11, 12, 14).

After each error and event, the relay has to be reset to clear the LEDs and the changeover contacts. To acknowledge and reset fault messages press the **C** button the front panel followed by the wrench button. The standard password is 1234.

1.2.4 Basic experiments with the transformer differential protective relay (745 3311)

To demonstrate the basics of differential protection, the first experiments are carried out without a transformer.

Objectives

Assemble the circuit according to the Fig. 18.

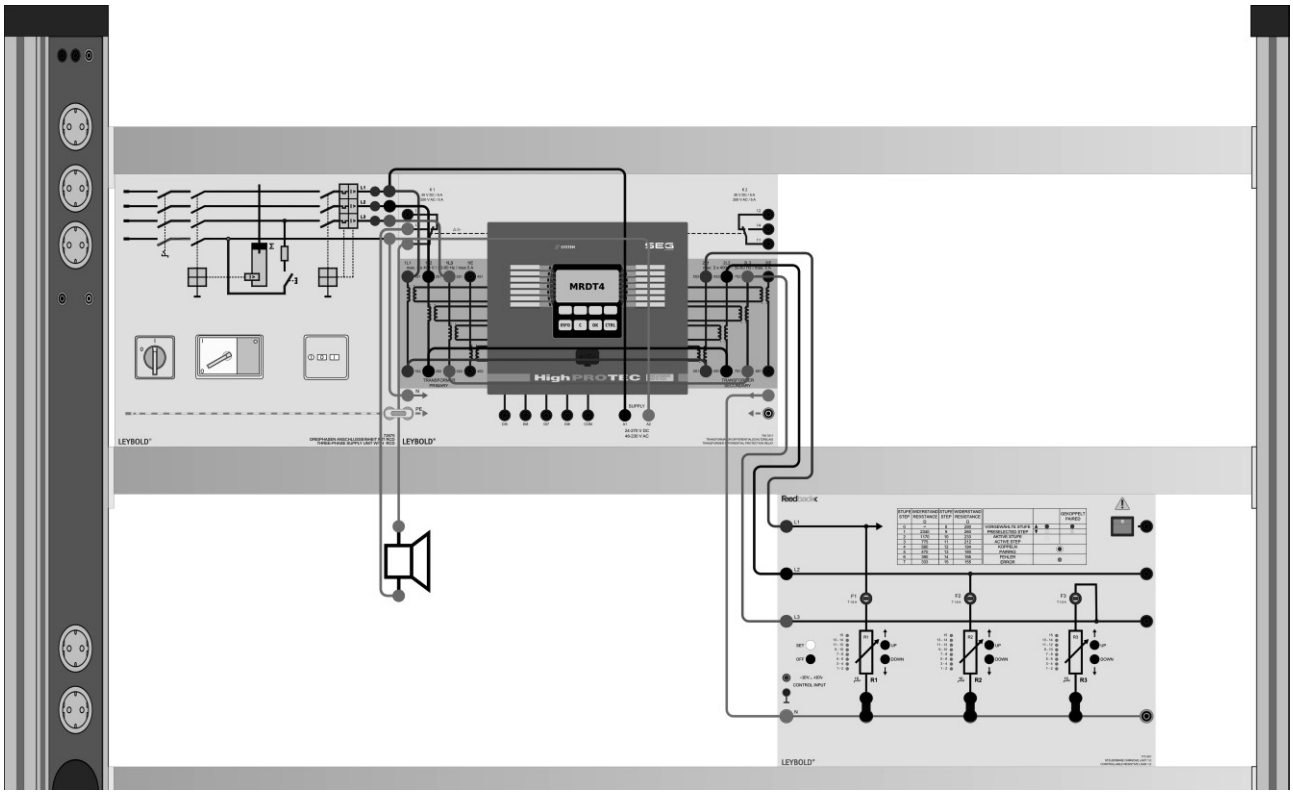

Fig. 1: Experiment assembly to investigate the response of a transformer differential protection.

With this setup, the same current flows through the primary side and the secondary of the relay.

- Switch on the power supply and the multimeter. Set it to continuity test mode.
- Switch on the resistive load.

If not already done, connect a computer to the relay via USB. Start the Smart View software and use (F2) to get the current data set of the device. Also, activate *Automatic Refresh* (Ctrl + F5).

In the menu *Operation / Measured Values* open the displays for *CT W1 / Current*; *CT W2 / Current* and *Id – 87*. These are the current measurements of the primary side (*IL* in CT W1), secondary side (*IL* in CT W2), the calculated differential current *Id* and go-through current *Is*, respectively. They are given separately for each phase L1 to L3. *Id* and *Is* are normalised to the base current *Ib*. Also, open the menu *Operations / Recorders / Faul rec* to get a list of all faults.

Pair all phases at the resistive load, to allow a balanced load only. Incrementally increase the load step to the maximum. Observe the phase currents, *Is* and *Id* and note down their value at the maximum load step below.

Switch off the load.

*IL1 = IL2 = IL3 = 1450 A; IS = 1.2*Ib; ID = 0*Ib*

Describe your observations.

The current on the primary and secondary side rises simultaneously.

The current I_s increases in the same way, divided by I_b = 1.2 kA. I_d is zero. No fault recorded.

Now, short-circuit one of the phases on the secondary site of the relay. For example, connect 6S1 and 6S2 with an extra lead. This simulates a fault in the transformer.

Starting at step 0, increase the balanced load incrementally again. Stop, when the relay trips and note the phase currents, *Is* and *Id*.

Switch off the load. For teachers: Values can vary.

CT1 IL1 = 391 A; IL2 = 391 A IL3 = 391 A; CT2 IL1 = 391 A IL2 = 104 A IL3 = 391 A;
*IS L1 = 0.32*Ib; IS L2 = 0.21*Ib; IS L3 = 0.32*Ib;*
*ID L1 = 0; ID L2 = 0.24*Ib; ID L3 = 0*

Read out the fault recorder.

Describe your observations.

Currents on the primary and secondary side are not equal at the shorted phase and Is rises more slowly.

Id is not zero on the faulty phase. It increases with a higher load step.

In the fault recorder: The type of fault is *Id -87* (Phase Current Differential Protection according to ANSI 87)

Here, the begin, duration and end of the fault as well as all measured variables are recorded.

To re-enable the relay, you must acknowledge the fault. To do this, press and hold the C button.

Compare the measured *Id* with *Id, min* set in the menu: *Protection Para/Set 1/Diff-Prot – 87/Id – 87*.

The measured *Id* is slightly higher, compared to the set Id, min.

Increase Id, min to 0.4**Ib*, transfer the settings to the device and repeat the experiment. At which current does the relay trip, now?

At a higher load step and higher current.

Turn off the power supply.