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Technical Description No 37A

Technical description for Power Autotransformer 400/150/30 KV Differential protection digital relays of transmission network

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1. Introductory remarks – range of application.

This technical description concerns digital autotransformer differential protection relays to be installed in 400/150/30 KV transmission power autotransformers. It establishes requirements for the performance, design, testing and operation of the relevant equipment and related software. The relays are primarily intended to provide fast and reliable clearance of faults in the autotransformer of 400/150/30 KV (three windings)
In addition to the fundamental protection function, supplementary functions are required covering the needs for operation in a modern working environment.

2. References and standards.

The items to be offered (hardware/software) will conform to the international standards and codes of practice, mainly:

- Currently valid IEC standards applicable for such devices covering performance, insulation and disturbance requirements, indicately :
  - Withstand voltage : (IEC 255-5)
    - Industrial frequency : 2KV, 50 Hz, 1min
    - Impulse test 1,2/50 μς 5KV
  - Disturbance tests (IEC 255-22/1,2,3,4)
    - High frequency 1MHz/2,5/1,0 KV (common/differential mode)
  - Fast transients 5/50 ns (IEC 255-21-4) : class III
    (IEC 255-21-1) : class III
    (IEC 801-4) : level 4
    (IEC 801-2) : class III
  - Vibration/shock requirements (IEC 255-21-1) : class II
    (IEC 255-21-3) : class II

In case of lack of international regulations, conformity to the national standards (i.e. the manufacturer's country standards) applicable for such devices could be considered, subject to purchaser's approval (ANSI, VDE etc.).
Finally, conformity statement of the manufacturer according to the provision of EU directive 73/23/EEC and 89/336/EEC will be required.

3. Operating environment.

- Network data
  The relays will be installed in the 400-150KV transmission network of IPTO.
  The main data of this network are shown below.
  Primary voltage : 400-150 KV
  System neutral : earthed
  Nominal frequency : 50 Hz (in emergency conditions frequency could be between 47.5 Hz to 51 Hz)
- CT characteristics
  400 KV voltage side : 400/1A, 60 VA, SP
  150 KV voltage side : 1000/1A, 60 VA, SP
  30 KV voltage side : 2000/1A,

- Power supply
  In extremely high voltage IPTO substation for the supply of the control/recording equipment is available a battery system providing voltage of a level of 220 VDC.

- Electromagnetic interference
  The relays will be installed in high voltage installation and it is the manufacturer's responsibility to provide all necessities on the relay (grounding, shielding) to assure reliable operation.

- Ambient conditions
  The relays will be designed for indoor operation over a temperature range from -5° to 55ºC and humidity range from 5% to 90%.

4. Protection performance and functions.

The differential relays will be of digital type and will ensure clearance of all types of phase to phase or phase to ground faults in the protected area providing three-phase tripping of circuit breakers.

a. They will have a percentage slope operating characteristic which prevents operation unless the differential currents are greater than a certain percentage of the through fault current. This percentage should be adjustable either continuously or by taps.

b. The out-of– balance current, produced by the autotransformer tapchanging or current transformer mismatch will be compensated by means of a percentage bias feature.

c. The relays will be equipped with harmonic – current restraint to discriminate between differential currents of sine wave form and these of distorted form in order to prevent incorrect tripping on unbalance caused by magnetizing inrush currents.

d. Matching of CTS ratios and phase angle compensation will be provided with relay settings without need of intermediate auxiliary current transformers.

e. The bidders shall submit operating time characteristics of the relays as a function of operating current (multiples of setting) versus operating time.

f. The relay will offer protection for all kinds of faults between phases as well as between phase and ground.

g. The type of the relay circuitry will be static or inductive or a combination of both.

h. The relay shall be enclosed in one case and will be of modular design with plug – in units.

i. Means will be provided in order to test the relay during maintenance work.

j. In addition to the normally-open contacts which are necessary for tripping order to the circuit breakers, at least two normally-open, free of voltage contacts will be provided for remote indication.

k. In addition the function of restricted earth fault will be included in the relay.

The assignment of inputs, outputs, LEDs can be easily restructured (programmable) for adaption to the on site conditions.

The contacts assignment can be performed by selection from an existing library in the memory of the relay and/or by establishment of equations based on the Boolean logic.
In addition to the basic protection function a package of extra functions is requested to meet the needs for the efficient operation of the network. Analytically :

- Fault recording : in the event of a fault and/or excitation the fault data will be stored in the relay for analysis. The fault data can be read remotely via modem. In the offer it must be clearly stated the memory capacity and the number/time length of the faults which can be stored. The capacity of the memory will permit the storage of at least four faults. It must be underlined that the fault report will include digital events and analog waveforms.
- Metering : it enables real time measurements of analog quantities (U,I) either locally or remotely.
- Self-monitoring : During operation self-monitoring tests will be performed and in case of an internal fault or loss of DC supply a signal is issued for protection blocking and/or warning.

5. Design and construction.

All functions will be included in a housing providing degree of protection IP51 according to IEC.
The construction preferably will be of modular design with plug-in units facilitating repairs and providing self-diagnostic (fault tracing) for each module.
The installation will be flush mounting.
All the appropriate special accessories (cables, plugs, etc.) for communication and testing have to be included in the offer.
The dc/dc converter accommodated in the relay housing will provide uninterrupted operation and it must have an input voltage of 220 V DC.
The analog to digital converter will digitize the input signal with a resolution of 12 bits (min requirements) for reliable wareform operation.
The trip output contacts will be of heavy duty with the following ratings (minimum requirements) :

- Current carrying capacity : 5 A
- Making capacity (L/R=40ms) : 1000W/VA
- Breaking capacity : 30W/VA

The switching/breaking capacity of the contacts must be mentioned in the offer.
The function of the alarm contacts will be assignable and their configuration can be done easily by the software locally or remotely. Signal contacts will provide information for the status of the relay in case of maloperation.

6. Communication and interfaces.

The relay must be equipped with the following ports and interfaces :

- User interface on the front plate of the relay ensuring dialog with the relay permitting complete setting (assignment of binary inputs, LED indicator, binary

outputs and establishment of boolean equations), operation, metering and fault reporting.
- The interface will be consisted of keyboard and display.
- LEDs on the front plate
- Serial interface (standard type serial port) for connection of a personal computer and for data transfer to the control center via modem.

The relay shall be capable for communicating via an Ethernet port with substation automation system, via IEC protocol 61850.

7. Software.

Software for the operation (included in the price of the offered devices) will be provided on the basis of a royalty free, non-exclusive, with irrevocable license to use for the operation of the relays. This term is applicable for the software covering all issues: Setting transmission, fault analysis, communication relay-PC and communication relay –remote station.
The software will be menu-driven, friendly to the user and easy to be followed even by an inexperienced operator. The fault analysis software will be capable of displaying on a VGA all analog waveforms and binary signals.

8. Tests.

The package to be offered will be in compliance with the standards mentioned in §2 above.
Tests certificates, issued by official laboratories, will be provided covering type and routine tests.
Existing certificates and tests reports will be accepted provided that they will be found satisfactory by the purchaser. Conformity to the relevant EU directives and guidelines is also required.

9. Additional requirements.

In case that intermediate transformers are needed bidders are requested to submit a complete vector diagram and study in which the choice of the transformation ratio and method of connection of the intermediate auxiliary current transformers will be justified for a reliable scheme of protection.
Offers that not including this study and the vector diagram (if needed) will not be taken under consideration.
Bidders have to provide full documentation concerning the installation, commissioning, operation, maintenance, trouble-shooting of the equipment. Furthermore complete instructions will be delivered for the operation of the related software in Greek or English language.
Also references and documentation will be provided which demonstrate that the offered hardware/software packages have been used in commercial scale and that the offered material is part of the manufacturer’s standard production.

In the references a list of users of the offered products, in the area of the power transmission networks in EU or/and North America countries, will be provided. The purchaser can request certifications of users concerning the good performance of the products.

After the assignment of the contract the contractor has to provide full technical documentation in Greek or English covering all relevant issues on the/operation/testing/troubleshooting ensuring an unobstacle operation by the IPTO personnel without any intervention of the manufacturer/contractor.

Guarantee of good operation for a period of at least ten (10) years.

All hardware/software features will be according to this specification. Any deviation has to be clearly described and identified in the offer.