

TECHNICAL DESCRIPTION TD-16/6

**DIGITAL DISTANCE PROTECTION RELAYS
FOR TRANSMISSION 150 kV NETWORKS**

SEPTEMBER 2024

ATHENS

1. Introductory remarks - range of application.

This technical description applies to digital distance protection relays to be installed in IPTO transmission power system of a nominal voltage of 150 kV. 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, selective and reliable clearance of faults in high voltage networks.

In addition to the fundamental distance protection function, supplementary or optional 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, indicatively :
 - Withstand voltage : (IEC 60255-27:2013)
 - Industrial frequency : 2 kV, 50 Hz, 1 min
 - Impulse test 1.2/50 μ s, 5 kV
 - Disturbance tests (IEC 60255-26:2013)
 - High frequency 1 MHz/2.5/1.0 kV (common/differential mode)
 - Vibration/shock requirements (IEC 60255-21-1) : class II
(IEC 60255-21-3) : class II
 - Radio Interference field strength as per IEC-CISPR 22
 - CCITT recommendation, the application of which will ensure reliable communication with the relays through the existing communication network.

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 directives 73/23/EEC and 89/336/EEC is required.

3. Operating environment.

- Network data

The relays will be installed in the 150 kV transmission network of IPTO.

The main data of this network are shown below:

Rated voltage : 150 kV rms

System neutral : solidly earthed

Nominal frequency : 50 Hz (in emergency conditions frequency could be between 47.5 Hz to 51 Hz)

Short-circuit level : 6500 MVA

- VT, CT characteristics

The secondary nominal voltage of the inductive or capacitive potential transformers is typically $120/\sqrt{3}$ or $100/\sqrt{3}$ and their class 3P/0.5.

Nominal secondary current of the CTs is 1 A and their class 5P20 and burden 60 VA.

- Power supply

For the supply of the control/recording equipment, a battery system is available in 150 kV IPTO substations, providing DC voltage of 110 V or 220 V (+10%, -15%).

- Electromagnetic interference

The relays will be installed in high voltage installation and it is the manufacturer's responsibility to provide all necessary measures (grounding, shielding) to assure reliable operation.

- Ambient conditions

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

4. Protection basic performance and functions.

Distance relays will be of numerical type and will ensure clearance of all types of phase or ground faults in the protected zone and direction providing selective three phase tripping. Fault detection will include impedance excitation and under-impedance, earth - fault and overcurrent excitation.

The impedance characteristics of the relay will be quadrilateral (or mho only for faults between phases), ensuring enhanced stability in case of load encroachment.

At least 3-distance zones will be provided (two zones forward and one zone reverse).

The reach of the distance zones can be selectable within the range 80 Ohm secondary in X-axis and 30 Ohm secondary in R-axis.

The relay will be fast with a maximum permissible operating time of 30 msec for all types of faults.

At least four groups of settings have to be stored in the relay, which must be selectable by the user during operation, either locally by on-the-relay interface or remotely via external signal.

Marshalling of binary inputs, binary output indicators on the relay front panel must be possible by means of the interface on the front or remotely.

The assignments of inputs, outputs can be easily restructured for adaptation 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 Boole logic.

In addition to the basic distance protection function, a package of extra functions is requested to meet the needs for the efficient operation of the network. Analytically :

- Switch-on-to fault feature (SOTF) : by monitoring the manual close command over a defined time period, SOTF will ensure instantaneous tripping without autoreclosing, when the circuit breaker is closed under fault conditions.
- Back-up overcurrent - time protection function : it will be activated in case of failure of voltage measurement circuit.
- Teleprotection: typically the permissive under-reach transfer trip (PUTT) scheme is used. Optionally other schemes will be provided (direct transfer zone extension, overreach or blocking scheme). For permissive tripping schemes, during weak infeed conditions, an echo function will be provided, enabling a fast tripping command back to the remote end of the line.
- Autoreclosing: fast three pole autoreclose.
- Synchrocheck: feature related to the autoreclosure function (for remote control). It ensures circuit breaker closing only when synchronization conditions are met (selectable by the user).
- Fault locator.
- 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. The fault report must include digital events and analog waveforms.
- Metering: it enables real time measurements of all analog quantities (V,I,P,Q) either locally or remotely via modem.
- Directional earth fault (DEF) function: it is used for clearing high resistance earth faults.
- Self-monitoring tests will be performed during operation and in case of an internal fault or loss of dc supply a signal is issued for protection blocking and/or warning.
- Circuit Breaker Failure Protection : by monitoring the circuit breaker status after an issue of a trip command over a time period, while the relay excitation is yet active, a circuit breaker failure signal is issued.

5. Design and construction.

All functions will be included in a housing providing degree of protection IP51 according to IEC 60529.

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 (special cables/ plugs interfaces, adaptors etc.) for

communication and testing must be included in the offer.

Automatic short-circuit of current contacts must be foreseen, in the case where the current input unit is of draw out type.

The dc/dc converter accommodated in the relay housing will provide uninterrupted operation and it must have an input voltage of 110 V DC or 220 V DC.

The resolution of the analog to digital converter must be at least 12 bits.

The **heavy duty trip output contacts** must have the following ratings (minimum requirements) :

- | | |
|----------------------------------|-------------|
| a. Current carrying capacity | : 5 A |
| b. Making capacity (L/R=40 ms) | : 1000 W/VA |
| c. Breaking capacity (L/R=40 ms) | : 30 W/VA |
| d. Number of contacts | : 6 |

If it is required by the inquiry, **two (2)** of the above six (6) contacts should be reinforced with the following ratings:

- | | |
|----------------------------------|-------------------------------|
| a. Current carrying capacity | : 5 A |
| b. Making capacity (L/R=40 ms) | : 30A/1s |
| c. Breaking capacity (L/R=40 ms) | : 5A (at 110V DC or 220 V DC) |
| d. Number of contacts | : 2 |

Configurable signaling output contacts

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|--|----------------------|
| a. Rated voltage | : 220 or 110 V DC |
| b. Continuous Current | : 1 A |
| c. Switching making capability | : 0.10 A at 250 V DC |
| d. Switching breaking capability
(for DC with L/R <40 msec) | : 0.10 A at 250 V DC |
| e. Number of contacts | : 10 |

Binary (Digital) Inputs

- | | |
|-----------------------------|-------------------|
| a. Rated Voltage | : 220 or 110 V DC |
| b. Rated Voltage tolerance | : +10%, -15% |
| c. Number of digital inputs | : 12 |

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 malfunction.

Twelve (12) digital inputs and sixteen (14) digital outputs at least are required.

6. Communication and interfaces.

The relay shall be equipped with all the appropriate ports for communication and interfacing purposes as described below:

1. One port suitable for connection to a PC (USB or RJ-45).
An operator program shall be available to enable user - friendly parameter setting, analysis of fault data and records and commissioning either locally or remotely.
2. Ports suitable for system interface (fiber optic) shall be available for connection to a digital computerized substation control system. The communication protocol shall be as per IEC 61850 and the relay shall support PRP (IEC 62439-3).
3. Apart from the internal synchronization clock, the relay must be capable of being synchronized via the substation automation control system master clock, which has the capability of G.P.S. synchronization, besides that of its own.
4. A number of 20 cables for the communication of the relay with PC must be included in the offer.
5. The relay must be equipped with an integral keyboard and display for parameter setting.

7. Software.

Software for the operation (3 copies at least, 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 by IPTO for the operation of the relays. This term is applicable for the software covering all issues: Setting transmission, calibration, fault analysis, communication between relay-PC and communication between 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 test reports will be accepted, providing that they will be found satisfactory by the purchaser. Conformity to the relevant EU directives and guidelines is also required.

9. Additional requirements

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 power transmission networks, will be provided. The purchaser can request certifications of users, concerning the satisfactory performance of the products.

After the assignment of the contract, the contractor must provide full technical documentation in Greek or English language, covering all relevant issues on operation/testing/troubleshooting, ensuring the effective operation of the equipment by IPTO personnel, without any intervention by the manufacturer/contractor.

Guarantee of good operation for a period of at least five (5) years.

The contractor will undertake the cost of training, in the premises of the supplier, of three engineers, including the transportation and accommodation costs.

All hardware/software features must comply with this specification. Any deviation must be clearly described and identified in the offer.

10. Certification

The offered devices shall be certified by conformance testing, performed in accordance with IEC 61850-10. The certificate must be of level A (level A means independent Lab, e.g. KEMA).

The certificate can be of level B (manufacturer's Lab), provided that the manufacturer's Lab has been qualified by the UCA International Users Group.

In the first case, the certificate (level A) must be submitted along with the technical offer. In the second case, both the certificate (level B) and the UCA International Users Group certification to the manufacturer, must be submitted with the technical offer.

ATTACHMENT "A"

1. Type of the offered relay :
2. Do the offered items conform to the international standards and codes of practice mentioned in paragraph 2? :
3. Analog Inputs of the relay:
 - a. Rated current :
 - b. Rated voltage :
4. Auxiliary supply voltage :
5. Auxiliary supply voltage tolerance :
6. Are the relays protected by electromagnetic interference? :
7. Temperature tolerance range :
8. Do the relays ensure clearance of all types of phase or ground faults in the protected zone and direction by providing selective three phase tripping ? :
9. Criteria used for fault detection :
:
10. Type of measurement characteristic (§ 4) :
11. Are the zones selectable? :
12. Number and description of the zones :
Reach of the zones? :
13. Operating (response) time of the relay :
14. How many groups of settings can be stored in the relay ? :
Are they selectable ? :
15. Is the Switch-on-to fault (SOTF) function available ? :
16. Are the relays equipped with back-up overcurrent - time protection function ? :

17. For the teleprotection function, indicate modes of operation. Is an echo function available for weak-infeed conditions?
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18. Are the offered relays equipped with autoreclosure feature? :
19. Is the offered relay equipped with synchrocheck? :
20. Is the offered relay equipped with fault locator? :
21. - Is the offered relay equipped with disturbance recording? :
- Can the fault data be read remotely via modem? :
22. How many faults can be stored in the memory of the disturbance recorder and what is the time length of fault? :
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23. Is the offered relay equipped with real-time measurement feature (V, I, P, Q) ? :
24. Is the offered relay equipped with directional earth fault protection function (DEF) ? :
25. Is the offered relay equipped with self monitoring (checking) feature? :
26. Describe how the breaker failure protection feature operates :
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27. Degree of protection of the relay case :
28. Is the offered relay of the modular design type? :

29. Is the offered relay suitable for panel flush mounting? :
30. Is the relay equipped with screw type terminals suitable for 2.5 mm² conductors :
31. Is automatic short-circuiting of the current contacts available in the case where the current input unit is of the draw out type? :
32. Heavy duty Output Contacts reinforced (if it is required by the inquiry)
- a. Number of heavy duty contacts :
 - b. Continuous current :
 - c. Short-time current (0.5 sec) :
 - d. Switching making capability :
 - e. Switching breaking capability :
33. Heavy duty Output Contacts
- a. Number of contacts :
 - b. Continuous current :
 - c. Short-time current (0.5 sec) :
 - d. Switching making capability :
 - e. Switching breaking capability :
34. Signaling contacts
- a. Are they configurable? :
 - b. Number of signaling contacts :
 - c. Rated voltage :
 - d. Continuous current :
 - e. Switching making capability :
 - f. Switching breaking capability :
35. Digital Inputs:
- a. Rated voltage :
 - b. Number of inputs :
36. Number and type of communication ports? :
37. Can the relay be set by PC? :
38. Can the software be used for parameter settings, analysis of fault data and record and commissioning? :
39. What is the communication protocol used for the connection of the relay to the digital computerized substation control system? :

40. Is the offered relay equipped with internal synchronization clock? :
:
41. Can the offered relay be synchronized via a master clock belonging to the substation automation control system? :
42. Is the required number of cables for the communication of the relay with PC provided? :
43. Is the relay equipped with an integral keyboard and display for parameter setting?:
44. Is software provided according to the requirements of paragraph 7? :
:
45. Type of the software? :
46. Is guarantee of good operation for a period of at least five (5) years provided ? :
47. Are the additional requirements of paragraph 9 taken into account in the offer ? :
48. -Are the offered devices certified by conformance test performed in accordance with IEC 61850-10? :
-Are certificates provided? :
48. Does the relay support PRP? :