



INDEPENDENT POWER TRANSMISSION OPERATOR S.A.  
NTPD/ SPECIFICATIONS & EQUIPMENT SECTOR S/S – EHV S/S

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## **SPECIFICATION SS - 68/3**

### **DIGITAL DIFFERENTIAL RELAY FOR AUTOTRANSFORMER PROTECTION.**

#### **I. SCOPE**

This hereby specification covers the requirements concerning the technical and operational characteristics and also testing requirements for digital differential relays used for the protection of 3-phase, 280MVA autotransformers with delta tertiary and of voltage ratio of 400/150/30KV and of wye - wye - delta connection.

#### **II. KEY WORDS**

Digital autotransformer differential relays, digital differential relays for three - winding transformers.

#### **III. USE**

The digital differential relays are to be used for the protection of 3 - phase 280MVA, 400/150/30KV autotransformers of wye - wye - delta (tertiary) connection.

#### **IV. STANDARDS**

The relays shall conform to the latest IEC standards. Relays based on ANSI / IEEE or DIN / VDE standards can be offered, subject however, to the Purchaser's approval.

#### **V. OPERATING CONDITIONS**

- |                      |                 |
|----------------------|-----------------|
| 1. Installation      | : Indoors       |
| 2. Temperature range | : -5°C to 55° C |
| 3. Relative Humidity | : 5% to 85%     |

## **VI. CHARACTERISTICS OF THE ELECTRICAL SYSTEM**

- |   |  |
|---|--|
| 1. Rated Voltage (phase to phase)                                       | : 400 KV rms<br>150 KV rms<br>30 KV rms                |
| 2. Maximum Operating Voltage  | : 420 KV rms<br>170 KV rms<br>36 KV rms                |
| 3. Rated frequency  | : 50 Hz  |
| 4. System Neutral   | : Solidly Earthed                                      |
| 5. Operating frequency range  | : 50 Hz $\pm$ 0.2 Hz                                   |
| 6. Rated short circuit level  | : 40 KA at 420 KV<br>25 KA at 150 KV<br>20 KA at 36 KV |
| 7. Maximum permissible duration of fault in order to maintain stability | : $\leq$ 500msec.                                      |

## **VII. CURRENT TRANSFORMER CHARACTERISTICS**

The digital differential relays will be used in conjunction with current transformers which have the following characteristics.

- 400 KV side : Ratio = 400/ 1A, Burden = 60VA, Accuracy class = 5P20
- 150 KV side : Ratio = 1000/ 1A, Burden = 30VA, Accuracy class = 5P20
- 30 KV side : Ratio = 2000/1A, Burden = 60VA, Accuracy class = 5P20

## **VIII. DIGITAL DIFFERENTIAL RELAY REQUIRED PROTECTION CHARACTERISTICS**

- |                          |   |
|--------------------------|---|
| 1. Protection capability | : a. Against all three and two phase internal faults.<br>b. Against all interterm faults<br>c. Against all phase to ground internal faults. |
|--------------------------|---|

- |  |   |
|--|---|
| 2. Operating Characteristic                                  | : Dual slope percentage operating characteristic which shall prevent operation unless the differential current is greater than a certain percentage of the through fault current.<br>This percentage shall be adjustable either continuously or by steps. |
| 3. Vector Current transformer ratio adaptation (correction). | : There shall be no need for external interposing CTs.  |
| 4. Blocking characteristics                                  | : a. Second harmonic blocking or restrain plus dc blocking for autotransformer inrush current.<br>b. Filth harmonic blocking against autotransformer overexcitation current.  |
| 5. Additional Blocking characteristics                       | : Restrain against external faults with current autotransformer saturation  |
| 6. Protection against out - of - balance current             | : The out- of- balance current produced by the autotransformer tap – changing or current transformer mismatch shall be compensated by means of the percentage bias feature.   |
| 7. Earth fault protection                                    | : A restricted earth fault protection shall be available  |

## **IX. DIGITAL DIFFERENTIAL RELAY REQUIRED TECHNICAL CHARACTERISTICS**

- |                                       |                        |
|---------------------------------------|------------------------|
| 1. Type of differential relay         | : Digital (Numerical). |
| 2. Input rated current                | : 1A.                  |
| 3. Auxiliary voltage supply           | : 220 V DC             |
| 4. Auxiliary voltage supply tolerance | : +10% -15%            |
| 5. Output Contacts                    |                        |
| a. Trip contacts                      |                        |
| - Number                              | : at least two (2)     |

- Continuous current rating : 5 A.
- Switching making capacity : 1000 W.
- Switching breaking capacity : 30W.
- Current rating for 0.5 sec : 30A.

b. Alarm contacts :

- Number of alarm contacts : at least four (4) selectable contacts, plus two NO contacts all free of voltage.
- Contact continuous current rating : 1A.

6. Construction

: The relay shall be of the draw - out type for panel surface mounting.

7. Relay Housing (case)

: The housing shall provide a degree of protection of IP51 as per IEC.

8. Self – diagnostics

: The relay shall be equipped with self -diagnostics capacity, thus facilitating repairs.

9. Short circuiting of contacts of the current input unit (if any)

: Automatic short – circuit of all current contacts shall be foreseen, if the input unit is of the draw -out type .

10. Construction design

: The construction preferably will be of the modular design with plug- units.

11. Configuration of the relay

: All settings (parameterization) shall be input by means of an integrated keyboard and a display and by a PC. The settings shall be stored in a non - volatile memory, so that they will not be lost even during interruption of the substation auxiliary voltage and relay's internal battery (if any).

## **X. DIGITAL DIFFERENTIAL RELAY REQUIRED ADDITIONAL FEATURES**

- |                                 |  |
|---------------------------------|--|
| 1. Fault Recording              | : All faults shall be recorded and stored for analysis. The capacity of memory shall permit the storage of at least four (4) faults. Capability shall exist so that the fault data can be read remotely via modem.<br>The recording shall include both analog and digital signals. |
| 2. Measurements (metering)      | : The measurement function shall be capable of measuring in real time all phase currents and capability shall exist so that this data can be read either locally or remotely via modem.  |
| 3. Synchronization              | : Besides an internal synchronization clock, the relay shall be capable of being synchronized via a substation automation control system's master clock which has capability of GPS synchronization besides of its own.  |
| 4. External Wiring of the relay | : The relay shall be equipped with screw type terminals suitable for 2.5 mm <sup>2</sup> conductors.   |
| 5. Special Accessories          | : Any special accessories needed for testing and communication purposes must be provided.(such as special cables, plugs, interfaces, adaptors etc)   |

## **XI. COMMUNICATIONS**

The relay shall be fitted with two (2) serial ports for reasons of interfacing and specifically with :

1. One serial port suitable for connection to a PC.  
An operator program shall be available to enable user - friendly parameter setting, analysis of fault data and records and commissioning either locally or remotely via modem.
2. One serial port suitable for system interface (fiber optic) shall be available for connection to a digital computerized substation control and protection system. The communication protocol shall be as per IEC-61850 or IEC 60870 - 5-103, or Profibus-fms, or Modbus/RTU or DNP 3.0
3. One serial port suitable for connection to a digital computerized substation control and protection system via the same protocol used by the substation control and protection system.

## **XII. SOFTWARE**

Software, preferably WINOOWS based, for the parameter setting analysis of fault data and records and commissioning shall be provided on a basis of a royalty free, non exclusive with irrevocable License to use by PPC S.A.

The software shall be user friendly and capable of displaying on VDU (screen) all analog wave forms and digital signals. The software shall be menu - driven.

## **XIII. TESTS**

### **1. Routine Tests as per IEC 60255 - 5**

- |                              |   |
|------------------------------|---|
| a. Dielectric Withstand test | : 2 KV rms, 50 HZ, 1 minute,<br>between all terminals and case earth. |
| b. Impulse Voltage test      | : 5 KV peak, 1.2/50 $\mu$ s, 0.5j                                     |

### **2. Type tests.**

- |  |  |
|--|--|
| a. Impulse Voltage test as<br>Per IEC-60255 - 5.                   | : 5 KV peak, 1.2/50 $\mu$ s, 0.5j  |
| b. High Frequency test as<br>per IEC -60255-22-1.                  | : 2.5 KV peak, 1MHz, t = 15 $\mu$ s,<br>400 shots/sec, duration = 2 sec.                           |
| c. Electrostatic Discharge test<br>as per IEC-60255-22-2 class III | : 4KV contact discharge,<br>8 KV air discharge both polarities.                                    |
| d. Fast Transient test as per<br>IEC-60255-22-4 class III          | : 2 KV, 5 KHz, burst length =15ms,<br>repetition rate=300ms, both polarities,<br>duration = 1 min. |
| e. Vibration test as per IEC- 60068-2<br>and IEC 60255 - 21-1      | : 10 Hz to 60Hz, 0.035mm amplitude.<br>60 to 500Hz, 0.5g acceleration.                             |

NOTE: In case of lack of IEC testing standards, the only other standards that could be considered are VDE and ANSI/IEEE, subject, however to the purchaser's approval.

#### **XIV. INFORMATION WHICH MUST BE PROVIDED BY ALL BIDDERS**

1. All necessary technical pamphlets and technical information so that the technical evaluation of the offered differential relay can be carried out.
2. Outline drawings with over-all dimensions and wiring diagrams of the offered differential relays.
3. Any test certificates for all specified type tests in this hereby specification may be submitted along with the technical offer.  
Acceptance or not of the submitted test certificates will be subject to the purchaser's approval.
4. A reference list shall be submitted and in which the following shall be included :
  - Country and buyer
  - Type of the relay
  - Number of units sold
  - Year of sale.
5. All bidders are required to complete attachment 'A'. Failure to comply with this request or submission of attachment 'A' incomplete shall constitute sufficient reason for rejection of the offer.

#### **XV. DATA WHICH MUST BE PROVIDED BY THE SUCCESSFUL BIDDER**

1. Complete functional and wiring drawings for approval before shipment of the relays.
2. Complete outline dimensional drawings for approval before shipment of the relays.
3. All necessary documentation concerning installation, commissioning, operation, maintenance, parameter setting and trouble shooting of the relay.
4. Complete instructions for the operation and application of the related software.

#### **XVI. PACKING**

Each relay with all of its units (if any) shall be packaged separately inside a robust box properly labelled.

## ATTACHMENT "A"

1. Type of the offered relay : .....
2. Operating temperature range of the relay : .....
3. Analog Inputs of the relay
  - a. Rated Current : .....
  - b. Rated Burden : .....
4. Digital Inputs
  - a. Rated Voltage : .....
  - b. Rated Voltage tolerance : .....
5. Trip contacts
  - a. Number of trip contacts : .....
  - b. Continuous current rating : .....
  - c. Switching making capacity : .....
  - d. Switching breaking capacity : .....
  - e. Current rating for 0.5 sec : .....
  - f. Rated Voltage : .....220V DC
6. Alarm contacts
  - a. Number of alarm contacts : .....
  - b. Are they selectable? : .....
  - c. Rated Voltage : .....220V DC
7. Auxiliary Voltage supply of the relay : .....
8. Auxiliary Voltage supply tolerance of the relay : .....
9. Is the offered relay of the draw-out type and suitable for surface panel mounting? : .....
10. Describe the operating characteristic of the relay : .....  
: .....  
: .....  
: .....
11. Is the relay equipped with current transformer ratio adaptation (correction)? : .....  
: .....  
: .....
12. Are second and fifth harmonics and autotransformer inrush currents blocked? : .....  
  
: .....



13. Is restrain provided against external faults with  
current transformer saturation? : .....  
: .....  
: .....  
: .....
14. Is the out- of- balance current due to tap-changing  
or current mismatch compensated? : .....
15. Is restricted earth fault protection provided? : .....  
: .....  
: .....
16. Is automatic short-circuiting of the current contacts  
available in the case where the current input unit (if any)  
is of the draw out type? : .....
17. Degree of protection of the relay case : .....
18. Is the relay equipped with screw type terminals  
suitable for 2.5mm<sup>2</sup> conductors? : .....
19. Is the relay equipped with an integral keyboard  
and display for parameter setting? : .....
20. Can the relay be set by PC? : .....
21. Is the offered relay equipped with self-diagnostics? : .....
22. Is the offered relay equipped with fault recording? : .....
23. Is the offered relay equipped with measurements  
capability? : .....
24. Describe in brief the measurement feature capabilities : .....  
: .....  
: .....
25. Can the offered relay be synchronized via a substation  
automation control system's master clock? : .....  
: .....
26. Is the offered relay equipped with two serial ports?  
One for connection to a PC, the other for connection  
to the digital computerized substation control system? : .....
27. What is the communication protocol used for the  
connection of the relay to the digital computerized : .....

substation control system?	:	.....
	:	.....
28. Is software provided?	:	.....
29. Type of software provided	:	.....
	:	.....
	:	.....
30. Is the offered relay of the modular type?	:	.....
	:	.....

*A. G./me/20.3.2002*  
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