

SPECIFICATION SS – 100/4
Revision No.4

DIGITAL DIFFERENTIAL RELAY FOR TRANSFORMER
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, power transformers of 40/50 MVA, 150/15,75 – 21 KV and of delta - wye connection.

II. KEY WORDS

Digital transformer differential relays, digital differential relays for two – winding transformers.

III. USE

The digital differential relays are to be used for the protection of 3 – phase 40/50 MVA, 150/15,75 –21 KV transformers of delta – wye connection. The zone of protection shall include and the 20 KV bus of the substation. (Transformer +20Kv-bus differential protection)

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

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

VI. CHARACTERISTICS OF THE ELECTRICAL SYSTEM

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| 1. Rated Voltage (phase to phase) : | 150 KV rms |
| 2. Maximum Operating Voltage | : 170 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 | : 25 KA at 150 KV |
| 7. Maximum permissible duration of fault in order to maintain stability | : $\leq$ 500m sec. |

VII. CURRENT TRANSFORMER CHARACTERISTICS

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

- 150 KV side : Ratio = 200/ 1A, Burden = 25VA, Accuracy class = 5P20
- 15,75 -20 KV side : Ratio = 950- 720/0,58A, Burden = 30VA, Accuracy class = 5P20 for a substation with the 20KV side installed outdoors.
- 20KV side: Ratio: 600/0,5A, Burden=15VA and Accuracy class = 5P10 for a substation with the 20KV side installed inside the control building of the substation.

VIII. DIGITAL DIFFERENTIAL RELAY REQUIRED PROTECTION CHARACTERISTICS

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| 1. Protection capability | :a. Against all three and two phase internal faults.
b. Against all interturn faults
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.

This percentage shall be adjustable either continuously or by steps.

3. Current transformer vector and ratio adaptation (correction).

: There shall be no need for external interposing CTs.

In other words, the relay must be equipped with capability of adjusting CT ratio and angle (phase) in its input.

4. Blocking characteristics

a. Second harmonic blocking or restrain plus dc blocking for transformer inrush current.

b. Fifth harmonic blocking against transformer overexcitation current.

c. Zero –sequence current filtering so that out of-zone earth faults are not seen by the transformer protection as an in-zone fault.

5. Additional Blocking characteristics

: Restrain against external faults with current transformer saturation.

6. Protection against out – of – balance current

: The out- of- balance current produced by the transformer 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

XI. DIGITAL DIFFERENTIAL RELAY REQUIRED TECHNICAL CHARACTERISTICS

1. Type of differential relay : Digital (Numerical).
2. Input rated current : 1A.
3. Auxiliary voltage supply : 110 V D C
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 at 110V DC
 - Switching breaking capacity : 30 W at 110V DC
 - Current rating for 0.5 sec : 30 A.
 - b. Alarm contacts :
 - Number of alarm contacts : at least two (2)
selectable contacts, plus
two NO contacts all free of
voltage.
 - Contact continuous current rating : 1 A.
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).

XII. 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. 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.

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| 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 ² conductors. |
| 5. Special Accessories | : Any special accessories needed for testing and communication purposes must be provided. (such as special cables, plugs, interfaces, adaptors etc) |

XIII. 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 system. The communication protocol shall be as per IEC 60870 – 5-103 or Profibus, or Lon or Modbus RTU or DNP3.0 or IEC – 61850.

XIV. SOFTWARE

Software, preferably WINDOWS 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.

XV. TESTS

1. Routine Tests as per IEC 60255 – 5

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| a. Dielectric Withstand test | : 2 KV rms, 50 Hz, 1 minute, between all terminals and case earth. |
| b. Impulse Voltage test | : 5 KV peak, 1.2/50µs, 0.5j |

2. Type tests.

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

XVI. 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 speci-

cation 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.

XVII. 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.

XVIII. PACKING

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

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 :
6. Alarm contacts
 - a. Number of alarm contacts :
 - b. Are they selectable? :
 - c. Rated Voltage :
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. Is the relay equipped with current transformer ratio and angle adaptation; :
13. Is the relay suitable for transformer + 20KV bus zone differential protection; :
14. Are second and fifth harmonics and autotransformer inrush currents blocked? :
:
15. Is restrain provided against external faults with current transformer saturation? :
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:
16. Is the out- of- balance current due to tap-changing or current mismatch compensated? :
17. Is restricted earth fault protection provided? :
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:
18. 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? :
19. Degree of protection of the relay case :
20. Is the relay equipped with screw type terminals suitable for 2.5mm² conductors? :
21. Is the relay equipped with an integral keyboard and display for parameter setting? :
22. Can the relay be set by PC? :
23. Is the offered relay equipped with self-diagnostics? :
24. Is the offered relay equipped with fault recording? :
25. Is the offered relay equipped with measurements capability? :
26. Describe in brief the measurement feature capabilities :
:
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27. Can the offered relay be synchronized via a substation automation control system's master clock? :
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28. 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? :
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29. What is the communication protocol used for the :
connection of the relay to the digital computerized
substation control system?
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30. Is software provided? :
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31. Type of software provided :
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32. Power consumption of the relay :
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33. Is the offered relay of the :
modular type?
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34. Are zero sequence currents filtered? :
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