



TECHNICAL DESCRIPTION TD – 32/2
POINT-ON-WAVE CONTROLLERS

I. SCOPE

This hereby technical description covers IPTO's requirement regarding design features, technical characteristics and testing of point-on-wave switching controllers for switching of 400kV or 157.5kV shunt reactors or compensated overhead or cable transmission lines or 155 KV shunt capacitor banks.

II. KEYWORDS

Point-on-wave controllers, controlled switching relays

III. STANDARDS

The point-on-wave controllers shall conform to the latest editions of IEC 60255 and IEC 61000 standards. ANSI/IEEE standards can be offered subject however, to the approval of IPTO.

IV. USE

The point-on-wave controllers shall be used in conjunction with single-pole operated circuit breakers to control the instant of closing and opening of 155 kV shunt capacitor banks or shunt reactors of 400kV or 157.5kV. The controllers shall be also used at 400kV or 150kV overhead or cable lines with connected compensating shunt reactors

V. OPERATING CONDITIONS

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|----------------------------------|---|-----------------------------------------------------------------------|
| 1. Installation | : | Indoors, in a relay kiosk of the substation or in a control building. |
| 2. Limits of ambient temperature | : | - 10 °C to +55 °C. |
| 3. Limits of relative humidity | : | 5% to 95% |
| 4. Altitude | : | Up to 1000 m above sea level. |
| 5. Pollution level | : | Moderate |

VI. ELECTRIC SYSTEM CHARACTERISTICS

1. Nominal Voltage (phase to phase) : 150 kV or 400 kV
2. Frequency : 50 Hz (under emergency conditions 47.5-51 Hz)
3. System earthing : solidly earthed
4. 155 kV capacitor bank connection : Star (wye) solidly earthed, without series inrush reactors
5. 157.5 / 400 kV shunt reactor connection : Star (wye) solidly earthed

VII. POINT-ON-WAVE CONTROLLER REQUIRED CHARACTERISTICS

1. Nominal supply Voltage : 110 or 220 V DC
(to be stated in inquiry)
2. Supply Voltage operating range : 80% to 110% of nominal
3. Input reference Voltage (V.T. secondary) : $100/\sqrt{3}$ or $120/\sqrt{3}$ V
4. Input Current (C.T. secondary) : 1 or 5 A
5. Number of A.C. current inputs : 3
6. Number of A.C. voltage inputs : 1
7. Accuracy of CB open – close commands : $\leq \pm 0.5$ ms
8. Binary Inputs - Outputs
 - a. Number of output contacts for CB control : at least six (6)
 - b. Binary Inputs - Outputs rated voltage : 110 or 220 V DC
 - c. Output contacts current rating for CB control : The contact current rating shall be sufficient to drive the circuit breaker's opening and closing coils without the need of an inter-posing auxiliary relay.
 - d. Short-time current of CB control output contacts : 30 A for 200 ms, at least.

- e. Making capacity of CB control output contacts : 1000 W at least, at L/R=40ms.
- f. Output contacts current rating for signaling. : 0.25 A
- g. Number of signaling contacts : At least three (3) plus one (1) for controller internal fault
- h. Number of binary inputs : At least six (6)
- 9. Ambient temperature input : Pt100 or 4-20 mA
- 10. Type of terminals : Screw type terminals, for 2.5 mm² size conductors (4 mm² for CT connection)

VIII. BASIC PERFORMANCE AND FUNCTIONS

1. The controller will be used for point-on-wave opening and closing of 170 kV or 420 kV single-pole operated circuit breaker. It will be specifically stated in the inquiry the type of application of the controlled switching: shunt reactor or capacitor bank or compensated transmission line switching.
2. For shunt capacitors, the ideal target point for making will be zero voltage (0°) at each phase, in order to avoid high inrush current. For shunt reactors and compensated transmission lines, the ideal target point for making will be peak voltage (90°) at each phase, in order to avoid high DC component of the inrush current. The making point leads the closing point (contact touching) by the pre-arcing time.
3. The target point for opening (contact separation) will be close before the zero current point, corresponding to peak voltage (90°) at each phase for all applications, in order to avoid restrikes and current chopping. The leading time before zero current will be small enough, in order not to cause current chopping, but also large enough, in order to create dielectric strength surpassing recovery voltage.
4. One reference voltage input will be used, which will be connected to a VT upstream of the controlled circuit breaker (network side). Three current inputs will be used, one per phase, which will be connected to CTs either upstream or downstream of the controlled circuit breaker.
5. Two binary inputs will be used for connecting of opening and closing commands to the controller.
6. The controller will include compensation for the variation of the operating times of the circuit breaker, due to changes of the control voltage and the ambient temperature. Additionally, adaptive control will be used to compensate for operating time drifting during the lifetime of the circuit breaker.

7. The ambient temperature will be measured by an outdoor sensor, which will be part of the supply.
8. One signaling contact will indicate fault of the controlled switching, including operating times of the circuit breaker falling out of range (circuit breaker drive mechanism malfunctions) and internal fault of the controller.

IX. ADDITIONAL REQUIREMENTS

1. Parameters setting will be realized via keypad on controller and/or via laptop PC. If settings can be implemented via PC, then the related software and communication cable must also be part of the supply.
2. The controller shall be suitable for panel surface mounting.
3. Detailed wiring drawings will be submitted, which will describe the connection of the controller to the circuit breaker, the reference VT, the CTs and the temperature sensor. The drawings will show also the optional by-pass of the controller, in case of an internal fault or manual operation (switch for manual operation). The drawings will include any special wiring requirement, e.g. shielding.
4. The manufacturer will submit detailed commissioning manual of the controller. The instructions will include also detailed description of all on-site measurements of circuit breaker switching times, which are required in order to fine-tune the setting parameters of the controller. The commissioning of the controller on-site will be carried out by IPTO's personnel, without requiring the presence of a manufacturer's specialist.
5. The commissioning manual shall include also recommendations, regarding the time when the above mentioned commissioning procedures should be repeated during the lifetime of the circuit breaker.

X. TESTS

A. Routine Tests

1. Power frequency voltage withstand test :
2 KV rms, 50 Hz, 1 minute, as per IEC 60255-27.
2. Protective bonding continuity test, as per IEC 60255-27
3. Functional test

B. Type tests

1. Impulse Voltage withstand test :
5 KV peak 1,2/50 μ s, as per IEC 60255-27.

2. Power frequency voltage withstand test :
2 KV rms, 50 Hz, 1 minute as per IEC 60255-27.
3. Electromagnetic immunity tests, as per IEC 60255-26 and relevant IEC 61000 standards
4. Electromagnetic emission tests, as per IEC 60255-26 and relevant IEC 61000 standards

XI. DATA TO BE SUBMITTED BY BIDDERS

1. Bidders must provide all information requested in "ATTACHMENT A" of this hereby technical description. Failure on the bidder's part to comply with this request will be taken as sufficient reason for rejection of the offer.
2. Type test reports, for the type tests required in par. X.B.
3. Technical pamphlets and brochures which will help the technical evaluation process.
4. Outline and wiring drawings of the offered controller including mounting instructions.

XII. DATA TO BE SUBMITTED BY THE SUCCESSFUL BIDDER

1. After the signing of the contract, the successful bidder shall furnish three (3) sets of drawings and commissioning manual, as requested in par. IX.3, 4, 5. These drawings and manual shall include outline dimensions and wiring connections of the controller as well mounting and setting instructions.
2. The ordering sheet for each type of controller, including all required options, shall be submitted for approval, prior to the controller shipment.

XIII. PACKING

The point-on-wave controllers shall be packed inside robust paper boxes, suitable for indoor storage.

“ATTACHMENT A”
POINT-ON-WAVE CONTROLLER

Data to be provided by bidders.

Failure to comply will constitute sufficient reason for rejection of the offer.

1. Type and manufacturer of the controller :
2. Ambient Temperature operating limits of the controller :
3. Humidity operating limits of the controller :
4. Nominal supply voltage of the controller :
5. Input reference Voltage :
6. Input Current :
7. Sensitivity to frequency variation :
8. Accuracy of switching times of CB open – close commands :
9. Number of output contacts for circuit breaker control :
10. Binary Inputs - Outputs rated voltage :
11. Short-time current of CB control output contacts :
12. Making capacity of CB control output contacts :
13. Output signaling contact current rating. :
14. Number of signaling contacts :
15. Number of binary inputs :
16. Which switching functions are available for CB control? (opening and/or closing) :
17. Is the controller suitable for control of single-pole operated three-phase CB? :

18. Type of load for which the controller is suitable (shunt reactor, capacitor bank, overhead line, cable line). State all that apply :
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19. Number of available three-phase current recordings (waveform) :
20. Can the controller compensate for supply voltage variations? :
21. Can the controller compensate for ambient temperature variations? :
22. Does the controller include adaptive control to compensate for CB operating times drifting? :
23. How is parameters setting achieved (through keypad or laptop PC) ? :
24. If settings are also carried out via PC, is then the relative software and communication cable provided? :
25. Describe how is the controller mounted on a panel. :
26. Weight of the controller :
27. Dimensions of the controller :
28. Type of terminals :
29. Are the terminals suitable for 2.5 mm² size conductors (4 mm² for CT connection)? :
30. Power consumption of the controller :
31. Can the controller be used in conjunction with three single-phase CTs and one single-phase VT? :
32. Number of A.C. current inputs :
33. Number of A.C. voltage inputs :