

June 2025

TECHNICAL DESCRIPTION TD-116/1

BAY CONTROL UNIT

I. PURPOSE

This Technical Description covers the general requirements of IPTO on the technical and construction characteristics of the bay control unit and is intended for installation in the Digital Protection and Control Systems (SAS) of the substations - substations in the Hellenic Electricity Transmission System (HETS). The purpose of the control unit is:

1. The collection of signals from the power equipment of the bay, relating to e.g. switch positions, statuses, alarms, as well as signals from adjacent power equipment (e.g. earthing switch positions) for the smooth and safe operation of the bay.
2. The collection of measured values and measurement data.
3. Data processing such as calculating V_{rms} , I_{rms} , P , Q , S , $\cos\phi$ and frequency values from input values as well as deciding which data and information will be transmitted to the central control unit in each sampling cycle.
4. Synchronization and phase harmonization in accordance with the provisions of the applicable technical specifications and technical documents of IPTO.
5. The choice of control position:
 - Locally (from the bay control unit itself).
 - Remotely (from the central control location of the "SCADA" or remote control centers).
6. The control and monitoring of the operation of switches, disconnectors and earthing switches, as well as the control of change of reception of MV/S, MV/LV substations and 30/0.4kV internal service substations, depending on the respective function of the bay it will serve.
7. The display of measurement values
8. The display of the single-line (mimicking) diagram of the bay, updated with the current status of the bay equipment elements (open-closed), on an appropriate screen provided by the bay control unit.
9. Mutual insurance, in accordance with the provisions of the applicable technical specifications and technical documents of IPTO.
10. The automated control sequences, in accordance with the provisions of the applicable technical specifications and technical documents of IPTO.

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11. The transmission and reception of commands, signals and measurements from the central bay control unit to other digital H/Ns and the central units of the PSSE via the IEC61850 Edition 2 communication protocol.
12. The transmission of data from the central bay control unit to the SCADA unit and vice versa.
13. Implementation of pole mismatch control for single-pole AC/DC.

II. KEYWORDS

bay Control Unit, Digital Control and Protection Systems.

III. REGULATIONS

The applicable regulations for the material in question will be (latest versions):

- IEC60255
- IEC61000
- IEC 60068
- IEC61850
- IEC 62351

IV. SYSTEM FEATURES

The bay control units will be installed within protection and control panels in HVs (150kV or 400kV) or in 400kV substations. The HVs/substations will either be AIS, with air insulation or GIS, with SF6 insulation. The control units will be used indicatively and restrictively in bay s:

- Overhead transmission lines,
- Cable transmission lines
- Mixed transmission lines
- A/M/S
- Producer or Distribution System M/S
- Capacitors
- Inductors
- A/D Balance Coupler
- Network Power/Voltage Control Systems (e.g. SVC, STATCOM)

The above HV/HVS consist of either one or two or three main buses.

The final composition of the device will be determined by the project requirements in accordance with the provisions of the applicable technical specifications and the technical documents of IPTO.

Additionally, these devices are intended to be used in a PSS which has the following technical characteristics:

1. Communication network PSS: IEC61850 Edition 2

2. PSE Network Topology:

Redundancy via parallel star-backup network (PRP) (According to IEC 61850-90-4/2020 and IEC 62439-3 -unless otherwise specified by IPTO)

3. Data transfer speed: 100 Mbps

4. Auxiliary Power Supply Voltage: 110Vdc, 220Vdc

V. REQUIRED FEATURES OF THE GENERAL SIGNAL UNIT

1. Operating Temperature Range: -25oC / +55oC
2. Storage Temperature Range: -25oC / +60oC
3. Humidity Range: +5% to 93% - non-condensing
4. Unit Protection Index: Front IP40, remaining parts of the unit IP20
5. Installation in a 19" Rack Panel.
6. Analogue Inputs connection to intensity meter:
 - a. 4 inputs with nominal current $I_r=1$ A
 - b. thermal resistance 100 A for 1sec
7. Analog Inputs connection with Voltage Transducer:
 - a. 4 inputs with nominal voltage $U_r=100....120V$
 - b. thermal resistance 450V for 10sec.
8. Digital Inputs:
 - a. Operating voltage: 110Vdc or 220Vdc
 - b. Input operating limits: +/- 20%
 - c. Input response time: <3ms
 - d. Isolation of external circuit with internal circuits via optocoupler.
 - e. Maximum number of Inputs per card: 16
 - f. In case of common terminal: Up to 8 Inputs
 - g. Possibility to add additional digital inputs: 16 digital inputs.
9. Digital Outputs:
 - a. For marking status differences and commands to A/Z and Earthers:
 - i. Switching Capacity: 15 A for 1sec
 - ii. Interrupting Capacity - 110Vdc: 0.3A for L/R=40msec
 - iii. Interrupting Capacity - 220Vdc: 0.2A for L/R=40msec
 - iv. Continuous Flow Capacity: 6A at 55 °C
 - v. Number of Operations under load: 1000
 - vi. Response Time: <6ms
 - vii. In case of common terminal: Up to 2 Outputs
 - viii. Maximum Number of contacts per card: 16
 - ix. Possibility to add additional digital outputs: 8 digital outputs
 - b. In the event that the signaling of statuses and commands to the A/D is done through an intermediate contactor located either in the protection and control panel or in the A/D mechanism circuit, then the following minimum characteristics apply:
 - i. Switching Capacity: 15 A for 1sec

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- ii. Interrupting Capacity - 110Vdc: 0.3A for L/R=40msec
 - iii. Interrupting Capacity - 220Vdc: 0.2A for L/R=40msec
 - iv. Continuous Flow Capacity: 6A at 55 °C
 - v. Number of Operations under load: 1000
 - vi. Response Time: <6ms
 - vii. In case of common terminal: Up to 2 Outputs
 - viii. Maximum Number of contacts per card: 16
 - ix. Possibility to add additional digital outputs: 8 digital outputs
 - c. In the case of commands to A/D directly to the opening and closing coils of the mechanism, then heavy duty contacts are required, the following characteristics apply:
 - i. Switching Capacity: 15 A for 1sec
 - ii. Interrupting Capacity - 110Vdc: 6A for L/R=40msec
 - iii. Interrupting Capacity - 220Vdc: 6A for L/R=40msec
 - iv. Continuous Flow Capacity: 6A at 55 °C
 - v. Number of Operations under load: 1000
 - vi. Response Time: <6ms
 - vii. Common terminal case: Oxi
 - viii. Maximum Number of contacts per card: 16
 - ix. Possibility to add additional digital outputs: 4 digital outputs
10. Possibility of adding 4-20 mA analog input/output cards (minimum 4 inputs and 2 outputs).
11. Ability to Control 15 Switching Elements
12. Liquid Crystal Display (LCD), which will display the following:
- a. Multiple pages capability
 - b. Page with the single-line diagram of all the switching elements and other power equipment of the bay . Also on the same page it will be possible to parameterize three measurements (At least three measurements e.g. line current, line voltage, bus voltage) and write text.
 - c. Page with the measurements of all the measured quantities that have been parameterized. The control unit will be able to measure:
 - i. Current of each phase
 - ii. The polar and phase voltages of the bay
 - iii. Real Power
 - iv. Reactive Power
 - v. Apparent Power
 - vi. Frequency
 - vii. Power Factor
 - d. Page with all sizes to be customized (for local customization)
 - e. Events log page
 - f. Page for configuring alarms (alarm)
 - g. Page for communication network parameters
 - h. Control unit diagnostics page
13. Indicator LEDs
- a. Device health indicator
 - b. At least 10 programmable LEDs, with indication description capability

14. Button on the front of the Control unit:
 - a. Local – Remote Operation
 - b. Navigation Button for selecting pages and parameters as well as selecting switching hardware for local operation from the Control Unit. We would like to point out that in the case of a control command on a switching element that is locked, a message should be displayed stating that the element is locked.
 - c. Button for entering the control command or a parameter
 - d. 4 buttons free for programming by the operator (it is acceptable for these buttons to be graphical on the unit's screen).
15. It will contain an algorithm for monitoring the health of device components and will have an auxiliary switching contact for signaling an internal error.
16. A/D status monitoring function
17. Digital Disturbance Recorder.
18. It will support at least the following communication protocols:
 - a. IEC61850 Ed.2 / IEC61850-8-1 MMS (Client) and GOOSE (Server)
 - b. PRP Redundancy Protocol (IEC62439-2)
 - c. NTP Client for time synchronization
19. It will support functions to prevent access to the unit by unauthorized personnel, e.g. access to the unit's functions only by registering the appropriate user and the appropriate access codes.
20. It will have the following Communication Ports at a minimum:
 - a. IEC61850 LAN A: Optical port for multimode optical fiber 50/125μmLC duplex100Mbps
 - b. IEC61850 LAN B: Optical port for multimode optical fiber 50/125μmLC duplex100Mbps
 - c. Ethernet 10/100Mbps (RJ45) – Copper cable connection
21. Device Power Supply Input Voltage: 110Vdc or 220Vdc

VI. SOFTWARE

It must also provide user-friendly software with a friendly environment for all device functions and, in any case, for the following tasks, which must be performed both locally and remotely:

- modeling and parameterization, for the control and supervision of the switching elements of the bay , as well as the mutual protections between the elements of the same bay , as well as elements of the bay with adjacent bay s
- the parameterization of digital and analog input (DI/AI)/output (DO/AO) signals
- entering the settings in the various software components
- the creation of the diagram display and therefore information on the screen.

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- the identification and treatment of malfunctions (diagnostic - troubleshooting -tool). The configuration program should also support on-line diagnostics functions and the ability to impose values (forced values).
- Include archiving functions (events, measurements, error logs, etc. in internal memory that retains data in the event of power loss – non-volatile memory).
- The ability to retrieve the device program from the device (upload), including all settings and other customizations
- The configuration of the device for the necessary MMS and GOOSE communications according to IEC61850-8-1

Additionally, the bay control unit will carry appropriate software for the implementation of the above functions, as well as "logical" functions (possibility of implementing logical functions such as programmable logic controllers - PLC), through the programming language either Function Block diagram or Ladder diagram according to IEC 61131-3.

The software for the parameterization/diagnosis (development/engineering - diagnostics) of the device in question will also be provided with the necessary license.

VII. TESTS

- They will have test certificates, which will have been issued by certified laboratories, and must cover all the required tests (routine and type) referred to in the standards of paragraph III - Regulations and the relevant standards confirming the reliability of the functions of paragraph V.

In particular:

The offered BCU (Bay Control Unit) device must be fully certified and compliant with the following international standards:

- i. **IEC 60255-1:** General requirements for electronic protection, automation and control devices. It is clarified that the presentation of an official certificate of conformity with this part of the standard (60255-1) is not required. However, compliance should be explicitly stated in the manufacturer's technical documents and specifications to be submitted as part of the project.
- ii. **IEC 61850 (Parts 6, 7-2, 7-3, 7-4, 8-1):** To support digital substation functions, interoperability and data exchange. An IEC 61850 Ed.2 certificate of conformity, issued by a UCA accredited laboratory, shall be provided.
- iii. **IEC 62439-3:** The device should support PRP (Parallel Redundancy Protocol) and/or HSR (High-availability Seamless Redundancy) functionality, ensuring uninterrupted and reliable communication in protection and control networks.
- iv. **IEC 60255-26 / IEC 60255-27:** Electromagnetic compatibility (EMC) and electrical and functional safety requirements.
The device must meet the following Insulation Withstand Voltage requirements:
 - a. **Industrial frequency withstand:** 2 kV, 50 Hz, for 1 minute

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- b. **Impulse voltage withstand test:** 5 kV, wave 1.2/50 μ s
- c. **Vibration Resistance – Compliance with IEC 60255-27 and IEC 60255-21-1**
The field control unit (BCU) should comply with the vibration resistance requirements as specified in the IEC 60255-27 standard and in particular in IEC 60255-21-1, which defines the relevant mechanical tests.
The BCU must meet at least Class 1 requirements for vibration resistance during operation, transport and storage.
Compliance with the requirements of this class must be documented with appropriate test certificates or test reports, which will be included in the technical documentation of the equipment offered.
- d. **High Frequency Disturbance:** Class III, 2.5 kV (common mode) / 1.0 kV (differential mode)
- e. **Electrostatic Discharge (ESD):**
 - i. **Class IV**– 12 kV (air) / 8 kV (contact) on the housing
 - ii. **Class III**– 8 kV (air) / 6 kV (contact) on communication ports
- f. **Radiated electromagnetic field (Radiated e/m field):** Class III, 10 V/m
- g. **Fast Transients:** 4 kV on power supply / 2 kV on I/O and data

Compliance with the above standards will be documented by submitting corresponding test certificates or declarations of conformity from accredited bodies.

- All documents proving the conformity of the equipment with EU directives must be submitted.
- They must have been certified through a conformity test performed in accordance with IEC 61850-10. The certification must be level A (level A means an independent laboratory e.g. KEMA). The certification may be level B (manufacturer's laboratory) provided that the manufacturer's laboratory is approved by the UCA International Users Group. In the first case (level A certification), the certificate must be submitted together with the technical offer. In the second case (level B certification), the certificate must also be submitted together with the technical offer, accompanied by the certificate from the UCA International Users Group, which the manufacturer's laboratory has.
- For the offered bay control units, the manufacturer must have and submit a sales list proving that 10 units have been sold to Electrical Power Systems in the last five years.

VIII. DEVICE MARKING

1. The device must bear the following markings on the outer casing (at a minimum):
 - Manufacturer's brand
 - Device type
 - Operating voltage.
 - Certification / Accreditation Body Symbols
 - Serial number

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- Year of manufacture
- Country of manufacture

The above markings must be indelibly written.

VIII. PACKAGING

It will come with appropriate packaging to prevent damage during transport and storage, in accordance with the manufacturer's instructions.

The manufacturer and type of device will be listed on the packaging.

X. INFORMATION TO BE PROVIDED BY ALL TENDERS

1. The manufacturer must provide complete technical data along with its offer, as required in the attached "Technical Specifications Sheet".
2. Technical brochures and technical data sheet of the equipment offered.
3. Any type test certificates. Acceptance or not of these certificates is at the discretion of IPTO.

XI. INFORMATION TO BE PROVIDED BY THE WINNER OF THE COMPETITION

1. Device manuals regarding programming, operation, installation and maintenance. All necessary manufacturer's software used for parameterization and control of the general signal unit will also be provided.

TECHNICAL DATA SHEET

BAY CONTROL UNIT

- 1 Manufacturer:
- 2 Type:
- 3 Supports IEC61850 Ed. 2 / MMS /GOOSE?
- 4 Does it support PRP (IEC62439-3)?
- 5 Does it support NTP Client?
- 6 Number of analog inputs for connecting a voltage meter:
- 7 Nominal current of analog inputs for connection of MV current
- 8 Analog input thermal resistance, for connection to a current transformer:
- 9 Number of analog inputs for connecting MV Voltage:
- 10 Nominal current of analog inputs for connection of MV Voltage
- 11 Digital Input Operating Voltage:
- 12 Expansion capability with additional digital output-input-analog 4-20mA cards:
- 13 Digital signal outputs:
 - i) Operating voltage:
 - ii) Coupling Capacity:
 - iii) Interrupting Capacity:
 - iv) Maximum continuous operating current:
- 14 Measurements that the device can perform:
- 15 Number of LEDs the device has:
- 16 Does it have a single-line bay diagram display screen?
- 17 Does it have the ability to operate the switching elements from the front of the control unit?
- 18 Does it have on-screen navigation in lists of events, parameters and communications settings?
- 19 Number of Ports for Copper cable with RJ45 connection - 100Mbps:
- 20 Number of Optical ports with LC duplex connection:

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- 21 Power Supply Voltage:
- 22 Can the unit be mounted in a 19" rack?
- 23 Insulation Withstand Voltage requirements:
- 24 Power frequency resistance
- 25 Impulse voltage resistance
- 26 Vibration resistance (at least Class I)
- 27 Resistance to EMC interference at high frequency
(High Frequency Disturbance) in common mode:
- 28 Resistance to EMC interference at high frequency
(High Frequency Disturbance) in differential mode:
- 29 Resistance to EMC interference:
Electrostatic Discharge (ESD)
- 30 Resistance to radiated electromagnetic field
(Radiated e/m field):
- 31 Resistance to fast transients: