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HELLENIC ELECTRICITY DISTRIBUTION
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TECHNICAL DESCRIPTION ND-NMID – 417

CONTROL & PROTECTION DIGITAL UNITS – MULTIFUNCTION RELAYS FOR MV SWITCHGEAR PANELS

I. SCOPE

This technical description covers the requirements regarding technical and operating features, as well as testing of the Control & Protection Digital Units (CPDUs) that include MV equipment's protection, monitoring and control functions. More precisely these CPDUs will be placed in Metalclad Switchgear MV Panels of the following categories: incoming panels from transformers TM, bus section panels BSM, interconnection panels ICM, overhead feeder panels OLM, underground feeder panels ULM, capacitor bank feeder panels CM and independent power producer connection panels IPPM.

The CPDUs as multifunction protection relays should be equipped with phase and earth overcurrent protection of definite and inverse time. The CPDUs placed in line feeder panels of OLM and ULM type must additionally be equipped with an under frequency function. Furthermore, the CPDUs placed in OLM panels must be equipped with auto-reclosing function, suitable for one rapid auto-reclosing and at least two sequential adjustable time delayed reclosings, and fulfill the requirements for the sensitive earth fault protection in overhead medium voltage distribution lines (SEF protection), where the direction criterion can be activated. OLM panels will be equipped with a suitable core balance current transformer for the detection of the low (sensitive) earth fault currents, according to Technical Description ND-NMID-418/October 2021.

Moreover, the CPDUs must function as units for the collection, depiction and tele transmission of measurements, signals, indications and status of the under monitoring power equipment, but also as units for the local or remote control of the equipment, provided that predefined criteria and conditions are fulfilled.

II. KEY WORDS

Control and Protection Digital Unit, Multifunction Relay, Phase and Earth Overcurrent Relay, Auto-Reclosing Relay, Sensitive Earth Fault Detection, Underfrequency Function

III. 20kV NETWORK ELECTRICAL SYSTEM CHARACTERISTICS

- | | |
|------------------------------|---------------|
| 1. Nominal Voltage | : 20 kV |
| 2. Maximum Operating Voltage | : 24 kV |
| 3. Number of phases | 3 |
| 4. Nominal frequency | : 50 Hz |
| 5. Basic Insulation Level | : 125 kV peak |

- | | |
|------------------------|---|
| 6. Short Circuit Level | : 10 kA |
| 7. Method of earthing | : The 20kV system is earthed (grounded) via a 12Ω resistor |

IV. USE

The CPDUs will be used:

- 1) to monitor mv bays power equipment via the selection, depiction and tele transmission of equipment's measurements, signals, indications and status,
- 2) to control the mv bays power equipment via the C/B's operation, locally or by tele-command, provided the fact that predefined criteria and interlock conditions are fulfilled,
- 3) to protect mv bays power equipment against faults.

V. STANDARDS

The CPDUs shall comply with IEC 60255-151, 60255-27, 60255-26 and 60255-21 Standards. CPDUs as per ANSI/IEEE can be offered, subject, however to HEDNO's approval.

VI. REQUIRED TECHNICAL CHARACTERISTICS OF THE CPDUs

1. Type of relay

Numerical

2. Construction-Installation

The CPDUs shall be in a case and must be suitable for flush panel mounting.

3. Degree of Protection of the relay's case

IP51 as per IEC

4. Operating Conditions

- | | |
|------------------------|---|
| a. Installation | : Inside the control building of the substation |
| b. Ambient temperature | : Minimum (-5°C)
Maximum (+50°C) |
| c. Altitude | : Up to 1000m above sea level |
| d. Humidity | : 5% - 90% |

5. Terminals of the relay

The terminals of the relay shall be suitable to be wired with 2,5 mm² size copper conductors.

6. Auxiliary Voltage Supply

The relay will be supplied with 110V DC with +20%, -20% variation.

7. Rated current of the relay input

Input current: $I_N = 5 \text{ A}$, $I_{Ns} \leq 1$ (e.g. 1 A or 0,2 A) [for SEF protection in overhead feeder panels]

8. Thermal and dynamic withstand capability of the relay

- a. $250 \times I_N (I_{NS})$ for 0.5 sec
- b. $100 \times I_N (I_{NS})$ for 1 sec
- c. $(30 \text{ to } 40) \times I_N (I_{NS})$ for 2 sec
- d. $(3 \text{ to } 4) \times I_N (4A \text{ for } I_{NS})$ continuous

9. Required protection functions of the relay

CPDUs installed in **all MV panel's types** will be equipped with the following functions:

- a. Definite time phase (50), earth (50N – residual (calculated)) and negative-sequence (46) overcurrent protection with two (2) stages for phase and earth $I_{>}$, $I_{>>}$ and $I_{E>}$, $I_{E>>}$, respectively, and one (1) stage for negative sequence $I_{2>}$. In total five (5) stages.
- b. Inverse time phase (51), earth (51N – residual (calculated)) and negative sequence overcurrent protection with characteristic curves as per IEC 60255-151.

CPDUs installed in **underground and overhead MV feeder panels, ULM and OLM**, will be additionally equipped with the following functions:

- c. Broken conductor function (46BC), which uses the ratio of negative to positive sequence current (I_2/I_1) to detect an unbalanced fault that may occur on the system due to an open circuit condition (broken conductor, misoperation of one of the switchgear poles, blown fuse). The broken conductor function shall operate with DT characteristic and will incorporate an undercurrent guard ($I_{<}$) to inhibit its operation when the three phase currents are below a user settable level (e.g. very weak loads). If a built-in functionality does not exist for this feature, the CPDU shall be equipped with user programmable logic capabilities to allow its implementation, and the Bidder shall provide substantial justification which should be clearly documented in attachments to its offer.
- d. Underfrequency function (81U). The monitoring of the frequency will take place via voltage measurement in the (semi)busbars.
- e. Fault locator function ("FL"), that according to fault's type and using the current and voltage measurements during the fault's event, calculates the impedance vector and sends the proper information to SCADA-DMS system, so that (with further processing of the characteristic data of the fault) the possible location of the fault in MV network will be suggested. The exact list of the data exported will be determined in cooperation with the contractor during the phase of submission for approval of the typical signal list.

Particularly, CPDUs installed in **overhead MV feeder panels, OLM type**, will have additionally the following functions:

- f. Two stages of sensitive earth fault protection, $I_{Es>}$ and $I_{Es>>}$, with definite time characteristic and ability to determine direction.
- g. Auto-reclosing (79) with three (3), at least, reclosings.
- h. Inrush detector feature to block/restrain the operation of selected phase and/or earth overcurrent elements during energization of multiple pole-mounted transformers. The inrush detector will operate on the second harmonic principle, when the second harmonic current exceeds a set percentage of the fundamental current.

The CPDUs that are to be installed in **capacitor bank feeder panels CM**, will have additionally

undervoltage protection, so that the capacitor banks will be disconnected in case of voltage loss. Also a time delay functionality will ensure that the reclosing of the capacitor banks will be allowed only if the required discharge time has elapsed.

Regarding the independent **power producer connection panels IPPM**, the requirements for ULM panels will apply if the independent line is underground and the requirements for OLM panels if the line is overhead or mixed overhead-underground. Furthermore, in IPPM panels there is no need for underfrequency protection functionality.

10. Required additional functions of the CPDU

a. Trip-circuit supervision function (74TC) to monitor continuously the availability and operability of the trip circuit including its incoming cables. It will provide open circuit monitoring both when the circuit breaker is in its closed and in its open position. It will also detect loss of circuit-breaker control voltage. An alarm signal will occur whenever the circuit is interrupted. The contractor is responsible for any extra equipment (e.g. resistance) needed for the implementation of this function. Optional, the contractor can provide a standalone 74TC relay.

b. Circuit breaker condition monitoring function to record various statistics (e.g. CB opening time, CB closing time, CB operations, summated CB current amps (or squared amps) interrupted by the CB per phase) related to circuit breaker trip operation history, which can be used for scheduling preventive circuit breaker maintenance. Every time the CB trips, the CPDU will integrate the measured current information and record statistics through counters, which may be reset to zero following a maintenance inspection or overhaul. When the result of this integration exceeds a limit value (e.g. the breaker wear-maintenance curve threshold, if provided by CB manufacturer), the relay will alarm via output contact, communications port, or front-panel display.

c. Current and Voltage Transformer (CT and VT) Supervision function to monitor continuously CT's and VT's circuits.

d. Integrated programmable logic functions (e.g. logic gates, timers, counters and flip-flops) to allow the user to implement its own protection and automation solutions (e.g. switchgear interlocking) and schemes via a graphical user interface. User defined messages shall be also generated and displayed on the CPDU upon activation of user defined logic.

e. At least two separate groups of protection settings shall be provided to address various system conditions and will be stored in the CPDU's non-volatile memory. Changes between the setting groups will be executed via the front interface (e.g. push button), through a dedicated contact input or through the communication port. The change of setting groups will be only possible if there are no protection or automation functions running. During the autorecloser cycle, if the CPDU receives an order to change setting groups, this order will be kept in memory, and will only be executed after the reclaim time has elapsed.

f. The CPDU's local user interface shall have a graphical display of the mimic diagram and the measurements of the panel. The CPDU will have function keys/push buttons for navigation in the menu and push buttons for control (e.g. CB OPEN & CLOSE, LOCAL & REMOTE CONTROL, RECLOSING ACTIVATION & DEACTIVATION, INSTANTANEOUS ACTIVATION & DEACTIVATION), eleven (11) programmable red LEDs for signals and eleven (11) programmable green LEDs for indications or alternatively all the indications can be clearly depicted in the home screen.

g. The CPDU shall continuously measure the phase currents, the sequence components of the currents, the residual current ($3I_0$ calculated, I_E) and the earth current I_G ($3I_0$ measured, I_{Es}) associated with the sensitive current measurement input. The CPDU shall also continuously measure the phase voltages, the sequence components of the voltages, the three-phase power (active and reactive), the

power coefficient and the frequency. In addition, the CPDU shall calculate the demand and the minimum and maximum demand currents over a user-selectable period. All type of panels CPDUs shall be able to measure the Total Harmonic Distortion/Total Demand Distortion – THD/TDD (%RMS), and also CPDUs for TM panels will be able to measure additionally the THD voltage. The measured information can be accessed locally via the user interface on the relay front panel display, locally or remotely via the HMI of the CPDU setting and configuration software and remotely via the communication interface and communication protocol IEC61850 .

h. The CPDU shall be equipped with a built-in self-diagnostics system that shall continuously monitor the state of the CPDU's hardware and the operation of the CPDU's software. Operation's personnel shall be alerted for any fault or malfunction detected. A permanent fault will block the protection functions of the CPDU to prevent incorrect operation.

11. Required setting ranges and accuracy limits of the relay

The limits are applied according to the CPDU's functions that are defined by the type of the panel that is to be installed in, according to paragraph 9.

A. Definite time overcurrent protection

- a. phase ($I_{>}$): $(0.1 \text{ to } 4) \times I_N$ with a step not greater than 0.1A
- b. earth ($I_{E>}$): $(0.05 \text{ to } 1) \times I_N$ with a step not greater than 0.05A
- c. SEF ($I_{Es>}$): 0.01 to 1 A secondary with a step not greater than 0.001 A
- d. negative sequence ($I_{2>}$): $(0.1 \text{ to } 3) \times I_N$ with a step not greater than 0.1A
- e. phase ($I_{>>}$): $(0.1 \text{ to } 20) \times I_N$ with a step not greater than of 0.1A
- f. earth ($I_{E>>}$): $(0.05 \text{ to } 1) \times I_N$ with a step not greater than of 0.05A
- g. SEF ($I_{Es>>}$): 0.01 to 1 A secondary with a step not greater than 0.001 A
- h. time delay (for $I_{>}$, $I_{E>}$, $I_{2>}$, $I_{>>}$, $I_{E>>}$): 0.05 - 60 sec with a step not greater than 0.05 sec
- i. time delay (for $I_{Es>}$, $I_{Es>>}$) : 0.05 - 180 sec with a step not greater than 0.05 sec
- j. pickup accuracy for ($I_{>}$, $I_{E>}$, $I_{Es>}$, $I_{2>}$, $I_{>>}$, $I_{E>>}$, $I_{Es>>}$): not greater than 3% of the set value
- k. dropout to pickup ratio for ($I_{>}$, $I_{E>}$, $I_{Es>}$, $I_{2>}$, $I_{>>}$, $I_{E>>}$, $I_{Es>>}$): not less than 0.95
- l. trip time accuracy for ($I_{>}$, $I_{E>}$, $I_{Es>}$, $I_{2>}$, $I_{>>}$, $I_{E>>}$, $I_{Es>>}$): not greater than $\pm 2\%$ or ± 50 ms, whichever is the greater

B. Inverse time overcurrent protection

- a. phase (I_p): $(0.1 \text{ to } 4) \times I_N$ with a step not greater than 0.1 A
- b. earth (I_{Ep}): $(0.1 \text{ to } 1.0) \times I_N$ with a step not greater than 0.1 A
- c. negative sequence (I_{2p}): $(0.1 \text{ to } 2.0) \times I_N$ with a step not greater than 0.1 A
- d. time multiplier: 0.05 – 1,5 sec (IEC) or 0.5-15sec (ANSI) with a step not greater than 0.05
- e. pickup accuracy for (I_p , I_{Ep} , I_{2p}): not greater than 5% of the set value
- f. dropout to pickup ratio for (I_p , I_{Ep} , I_{2p}): not less than 0.95
- g. trip time accuracy for (I_p , I_{Ep} , I_{2p}): not greater than $\pm 5\%$ or ± 40 ms, whichever is the greater

C. Broken conductor

- a. I_2/I_1 pickup: from 20% to 100% with step not greater than 1%
- b. time delay: from 0.1 to 100 sec, with step not greater than 0.1 sec
- c. Min phase current : $0.1 \times I_N$ or less

D. Inrush blocking/restraint

- a. 2nd harmonic content (%): from 5% to 40% of the fundamental frequency, with a step not greater than 1%
- b. time delay (if applicable): from 0.05 to 20 sec, with step not greater than 0.05 sec

E. Auto-reclosing

- a. Setting range for the dead time during the fast reclosing : 0.1–2 sec in steps not greater than 0.01 sec
- b. Setting range for the dead time during the first delayed reclosing : 0.5–15 sec minimum, in steps not

greater than of 0.5 sec

- c. Setting range for the dead time during the second delayed reclosing: 0.5–15 sec minimum, in steps of 0.5 sec
- d. Setting range for the reclaim (reset) time of the CPDU after successful reclosing cycle : 1-300 sec in steps of 0.5 sec
- e. Setting range for locking the autoreclosing whenever there is a manual close CB command : 0-60 sec in steps of 0.5 sec.

F. Underfrequency Protection

- a. Activation setting : 45-50 Hz, continuous or by steps ≤ 0.1 Hz
- b. Operation time : 0.05 – 100 sec, step not less than 0.05 sec
- c. Activation – deactivation difference : less than 0.1 Hz

G. Measurement accuracy

- a. Phase currents: not greater than $\pm 1\%$ of reading
- b. $3I_0$ (residual current – calculated): not greater than $\pm 2\%$ of reading
- c. I_G (earth current): not greater than $\pm 1\%$ of reading (associated with SEF current input)
- d. I_1 (positive sequence current): not greater than $\pm 2\%$ of reading
- e. I_2 (negative sequence current): not greater $\pm 2\%$ of reading
- f. Voltages : not greater than $\pm 1\%$ of reading
- g. Frequency: maximum allowed fault ± 0.05 Hz for every sharp voltage change

12. Required characteristics and features of auto-reclosing

The following stands for CPDUs installed in OLM panels.

- a. Number of reclosings (shots) : minimum three (3), one (1) for fast reclosing and two (2) with delayed reclosings.
- b. Mode of circuit breaker's operation during auto-reclosing : 3-pole operation of the circuit breaker

c. Mode of operation of the auto-reclosing:

The CPDU must be suitable for selection of one of the following operation functions:

- Auto-reclosing OFF. Reclosing is not possible.
- One reclosing, either fast or delayed.
- One fast and one delayed reclosing.
- One fast and two delayed reclosings

d. Description of the operation of the auto-reclosing:

In case of a fault (phase or earth), any of the stages of the definite or the inverse time function shall be activated based on the user's settings and provide a tripping command to the circuit breaker in time set by the user. Either the auto-reclosing function is energized or not depending on the overcurrent stage that was initially excited (this is determined by the settings of the user). If the auto-reclosing function is energized, then it takes over, and after a programmed time, it provides a closing command to the circuit breaker.

If the fault is still present, then any overcurrent stage of the definite or inverse time function, depending on the settings of the user, shall assume control and a tripping command be provided to the circuit breaker after a specific programmed time.

The auto-reclosing function provides again, after a programmed time, a closing command to the circuit breaker. If the fault is still present, then any overcurrent stage of the definite or inverse time function, depending on the settings of the user, assumes control and provides a tripping lockout command to the circuit breaker after a programmed time. The circuit breaker is locked in this position since the total number (according to the settings of the user) of reclosings is reached.

- e. The CPDU shall be equipped with a time configurable function for blocking the auto-

reclosing function, wherever the circuit breaker is manually closed.

f. The CPDU shall be equipped with operation counter for counting the rapid and delayed reclosings.

13. Additional required inputs

The CPDU must have at least twelve (12) binary inputs 110V D.C., like the following:

- a. Input for signal of C/B's uncharged spring,
- b. Input for signal of C/B's low SF₆ pressure,
- c. Set of inputs for the indication of C/B's position,
- d. Set of inputs for the indication of carriage's position,
- e. Set of inputs for the indication of earthing switches' position,
- f. Input for signal of fault of an adjacent CPDU,
- g. Input for signal of voltage miniature circuit breaker's tripping,
- h. Set of inputs for the monitoring of 110 V DC

It is emphasized that in case that the supervision of the circuits of the C/B's tripping coils takes place via binary CPDU inputs, the number of the above inputs should be increased appropriately. Any additional equipment for the supervision of the circuits of the C/B's tripping coils must be included.

It is noted that all the above binary units have been considered as independent and so suitable for connection to different voltages (P,Q,S,I). For the cases that the proposed CPDU have groups of binary inputs with the same terminal, then the number of these inputs should be increased accordingly.

14 Output contacts for control and signaling

A. Output contacts for C/B control (heavy duty)

The CPDU shall be equipped with the following number of control (command) heavy-duty contacts and with the following technical characteristics.

- a. Number of contacts with regard to CB's control and trip:

One (1) NO contact for opening or tripping and

One (1) NO contact for closing or making through the autoreclosing function

- b. The CPDUs that are to be installed in CM panels will have six extra output contacts for the control of the three banks of capacitors.

- c. Technical characteristics of control (command) contacts

Continuous rated current: 5A

Short time current rating (Making capability): 30 A for 0,5 sec

Breaking capability at 110 V D.C.: $\geq 0,25$ A

B. Alarm output contacts

The CPDU shall be equipped with the following number of alarm contacts, according to the functions that is equipped depending on the type of panel that is to be installed:

- a. Number of contacts with regard to the individual:

O/C Phase ($I>$ and $I>>$): 1 NO

O/C Earth ($I_E>$ and $I_E>>$): 1 NO

SEF ($I_{Es}>$ and $I_{Es}>>$): 1 NO

O/C Negative sequence ($I_2>$) and protection of broken conductor: 1 NO

Underfrequency ($f <$): 1 NO

Therefore, the CPDU must be equipped with five (5) contacts defined as above or programmable by the user.

- b. Number of contacts with regard to the auto-reclosing function: 2 NO
One for indicating that the autoreclosing function has been blocked.
One for indicating that the instantaneous elements ($I >$, $I_E >$) have been blocked.

Total number of alarm contacts: seven (7).

- c. Technical characteristics of the alarm contacts

Continuous rated current: 1A

Short time current rating - Making capability at 110 V D.C.: 8 A for 0,5sec

Breaking capability at 110 V D.C.: 0,25 A

It is noted that all the above binary units have been considered as independent and so suitable for connection to different voltages (P,Q,S,I). For the cases that the proposed CPDU have groups of outputs with the same terminal, then the number of these inputs should be increased.

15. Communications

- a. The CPDU shall be capable for communicating through fiber optic gates (or electrical in case that the network data switches are not compliant for optical interface) with a substation automation system via IEC 61850 communication protocol.

The redundancy level of the network topology between RTU and CPDU is of outmost importance, as well as the connection way of the accessory equipment. Any first failure in the physical level of communication (optical fiber / Ethernet cable, network data switch, including failure of its supply) must not result to loss of transmitted data. The restoration of communication via alternative route must be immediate.

Every CPDU must be equipped with two Ethernet gates that will be PRP (Parallel Redundancy Protocol) compliant or compliant to any other protocol needed for the configuration of the digital substation.

- b. SNTP protocol shall also be available for time synchronization.
- c. The CPDU shall be also equipped with an Ethernet or Usb gate, for the connection with a laptop.
- d. Together with the CPDUs, the supplier must provide any software needed for the setting and communication of the CPDU with a laptop and the substation automation system.
- e. Together with the CPDU, the supplier must provide cables for the communication with a laptop.

16. Fault, event and disturbance recording

The function of the fault, event and oscillographic recording shall be used for recording of phase and ground (earth) currents during fault conditions, simplifying post-fault analysis and improving understanding of protection scheme operations.

- a. The fault and event recording will be triggered by any protection alarm and trip signal or pick up/dropout, by any logic input change of state, by any setting change and by any self test event. The CPDU shall have the capacity to store in non-volatile memory the most recent events with each event date and time stamped to 1 ms resolution. In case of a fault event, the fault record values (e.g. fault time and date,

fault type, measured current per analog channel at the time of fault) will be stored for post-processing.

b. The oscillographic recording will be triggered by any protection alarm and trip signal, as well as by any logic input and remote command. Each oscillographic record shall contain the waveform of each measured analogue signal (actual sampled values) as well as the digital input and output status information for the whole record length, which shall be 3 sec at least. An adjustable pre- trigger time shall allow data capturing before the fault/event initiation. The relay shall store at least 5 of the most recent oscillographic records in its volatile memory. The oscillographic records shall be exported to Comtrade standard format.

c. The fault, event and oscillographic recording information can be accessed locally via the user interface on the CPDU's front panel or remotely via the communication interface. For both cases, the contractor is obliged to give the relative software.

17. CPDU Dimensions

The following dimensions stand only for the supply of individual CPDUs and not for CPDU that are part of metalclad switchgear supply.

- Maximum height 30 cm
- Maximum width 25 cm
- Maximum depth 30 cm

VII. TESTS

A. Routine Tests (as per IEC 60255-5)

1. Power frequency voltage test : 2 kV rms, 50 Hz

B. Type Tests

1. Impulse voltage test : 5 kV crest, 1.2/50 μ s, 0.5J
(as per IEC 60255-5) 3 positive and 3 negative pulses in 5 sec intervals
2. High frequency test : 2.5 kV crest, 1MHz,
(as per IEC 60255-22-1) t=15ms, 400 pulses/sec, duration=2 seconds
3. Fast transient test : 2 kV 5/50 ns, 5 kHz,
(as per IEC 60255-22-4 and 61000-4-4) pulse duration 15 sec, iteration rate : 1 /300 ms for 1 minute
4. Mechanical vibration test : 60-150 Hz, 0,5g acceleration
during operation sweep rate: 1 octave / minute
(as per IEC 60255-21-1 and 60068-2-6) 20 cycles in 3 orthogonal axes.
5. Electrostatic discharge test : 8 kV contact discharge, 15kV
(as per IEC 60255-22-2, class IV) air gap discharge, both polarities, 150pF, Ri=330 Ω

VIII. DATA TO BE SUBMITTED BY ALL BIDDERS

a. Wiring and dimensional (outline) drawings

Bidders are requested to submit along with their offers outline drawings of the CPDU, wiring diagrams, all the necessary diagrams for the understanding of the CPDU's operations, technical brochures and data essential for the complete description of the CPDU offered.

b. Completion of the Attachments A. Failure to comply or inadequate completion will constitute sufficient reason for rejection of the offer.

c. Type test certificates for the type test specified in this hereby technical description. Acceptance or not of these certificates lies on HEDNO's judgment.

IX. PACKING

The CPDUs shall be delivered packed properly inside robust paper boxes, one unit per box, proper for this type of equipment.

**ATTACHMENT 'A' CONTROL & PROTECTION DIGITAL UNITS –
MULTIFUNCTION RELAYS FOR MV SWITCHGEAR PANELS**

Failure to answer all following questions will result in rejection of the offer.

1. Type and manufacturer of the CPDU
 2. Are the CPDUs equipped with definite time and inverse time phase and earth overcurrent protection?
 3. Are the CPDUs that are to be installed in OLM and ULM panels equipped with the function of underfrequency?
 4. Are the CPDUs of OLM panels equipped with auto-reclosing function?

Is the auto-reclosing function suitable for one rapid reclosing and at least two sequential delayed reclosings?
 5. Can the CPDUs that are to be installed in OLM panels, detect sensitive earth faults with the capability to activate distance criterion (SEF protection)?
 6. Degree of protection of the CPDU case
 7. Operation temperature category of the CPDU
 8. Altitude Resistance
 9. Humidity Resistance
 10. Type of the terminals of the CPDU
 11. Are the terminals of the CPDU suitable to be wired with 2,5 mm² size copper conductors?
 12. Auxiliary Voltage Supply of the CPDU
 13. Rated current of the CPDU input
 - For SEF protection
 - 14 Thermal withstand capability of the CPDU
 - For 0.5 sec
 - For 1 sec
 - For 2 sec
 - Continuous
 15. Does the offered CPDUs comply with the requirements of paragraph VI – 9 of this hereby technical description?

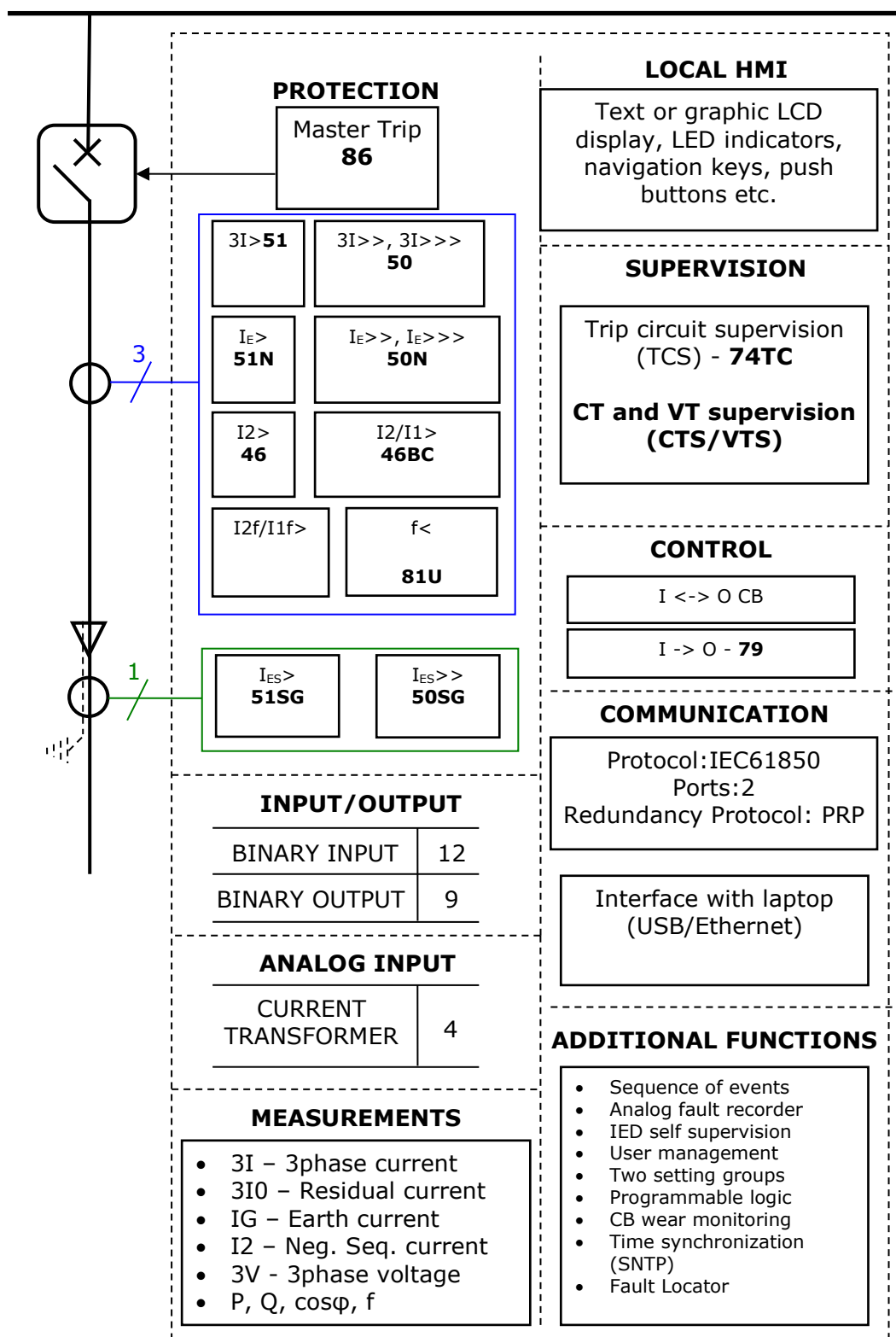
(according to the type of MV panel to be installed)
 16. Does the offered CPDUs comply with the requirements of paragraph VI – 10 of this hereby technical description?
 17. Setting ranges of the relay
 - A Overcurrent of definite time
 - a. phase ($I >$)
 - b. earth ($I_E >$)
 - c. SEF ($I_{ES} >$)

	d. negative sequence ($I_2 >$)	
	e. phase ($I >>$)	
	f. earth ($I_E >>$)	
	g. SEF ($I_{ES} >>$)	
	h. Delay time	
	(for $I >, I_E >, I_2 >, I >>, I_E >>$)	
	i. Delay time	
	(for $I_{ES} >, I_{ES} >>$)	
	j. Pickup accuracy	
	(for $I >, I_E >, I_{ES} >, I_2 >, I >>, I_E >>, I_{ES} >>$)	
	k. Dropout / pickup ratio	
	(for $I >, I_E >, I_{ES} >, I_2 >, I >>, I_E >>, I_{ES} >>$)	
	l. Trip time accuracy	
	(for $I >, I_E >, I_{ES} >, I_2 >, I >>, I_E >>, I_{ES} >>$)	
B	Overcurrent of inverse time	
	a. phase ($I_p >$)	
	b. earth ($I_{EP} >$)	
	c. negative sequence ($I_{2p} >$)	
	d. time multiplier	
	e. Pickup accuracy	
	(for I_p, I_{EP}, I_{2P})	
	f. Dropout / pickup ratio	
	($\gamma I \alpha I_p, I_{EP}, I_{2P}$)	
	g. Trip time accuracy	
	($\gamma I \alpha I_p, I_{EP}, I_{2P}$)	
C	Broken Conductor Protection	
	a. Pickup Setup I_2/I_1	
	b. Delay Time	
	c. Min phase current (if applicable)	
D	Inrush blocking / restraint	
	a. 2th harmonic content (%)	
	b. Time delay (if applicable)	
E	Auto reclosing	
	a. Setting range for the dead time during the fast reclosing:	

	b. Setting range for the dead time during the first delayed reclosing:	
	c. Setting range for the dead time during the second delayed reclosing	
	d. Setting range for the reclaim (reset) time of the relay, after successful reclosing circle	
F	Underfrequency protection	
	a. Activation settings	
	b. Operation time	
	c. Activation-deactivation difference	
G	Measurement accuracy	
	a. Phase currents	
	b. $3I_0$ (residual current - calculated)	
	c. I_G (earth current)	
	d. I_1 (positive sequence current)	
	e. I_2 (negative sequence current)	
	f. Voltages	
	h. Frequency	
18	Required characteristics of the autoreclosing	
	a. Is the isolation of the auto-reclosing function possible?	
	b. Is the CPDU suitable for one rapid reclosing (rapid or delayed)?	
	c. Is the CPDU suitable for one rapid reclosing and one delayed reclosing?	
	d. Is the CPDU suitable for one rapid reclosing and two delayed reclosings?	
	d. Number of reclosings	
	e. Is the CPDU equipped with a counter for counting the rapid and delayed reclosings?	
19	Characteristics of the control (command) contacts.	
	a. Number of contacts related to C/Bs Control and Tripping	
	b. Number of contacts for controlling capacitor banks (at CPDUs of CM panels)	
	c. Rated current of the control (command) contacts	
	d. Short time current rating (0.5sec) of the control (command) contacts at 110 V DC making	
	e. Breaking capability of the control (command) contacts at 110 V D.C.	

- 20 Characteristics of the alarm contacts
 - a. Number of alarm contacts for protection signaling (according to the type of panel to be installed):
 - b. Are the alarm contacts freely programmable?
 - c. Number of contacts for auto reclosure and instantaneous
 - d. Rated current of the alarm contacts
 - e. Short-time current (0,5sec) rating of the alarm contacts
 - f. Breaking capability of the alarm contacts at 110 V D.C.
- 21 Does the relay cover the requirements in paragraph VI-15 of this technical description?
 - a. Is the CPDU compatible to IEC 61850?
 - b. Can the CPDU communicate via two optical gates and is it compatible to PRP redundancy protocol or other protocol that has been requested?
 - c. Is a SNTP protocol included in the relay for time synchronization?
- 22 Does the relay cover the requirements in paragraph VI-16 of this technical description?
 - a. Is the relay capable of event and oscillographic fault recording?
 - b. Resolution of events
 - c. Minimum recording time
 - d. Min number of saved new oscillograms in the volatile memory of the relay
23. Detailed description of all the additional inputs of the relay
24. Power consumption of the relay in VA
25. Weight of the relay
26. Outline dimensions of the relay
27. Is the relay suitable for panel flush mounting?
28. Is the relay equipped with a key pad and port (usb or Ethernet) for setting and parameterization purposes?
29. Is the required software for the relay settings and communication provided?
30. Are cables for the communication of the CPDU with PC provided?

PROPOSED PROTECTION SCHEME FOR OLM FEEDERS (IN DISTRIBUTION SUBSTATIONS) – MINIMUM TECHNICAL REQUIREMENTS



The protection schemes for the rest MV panels will be configured according to the requirements of this technical description.