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NMID-9: AUTOMATIC VOLTAGE REGULATOR DEVICE FOR HV/MV TRANSFORMES

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AUTOMATIC VOLTAGE REGULATOR DEVICE FOR HV/MV TRANSFORMERS

1. SCOPE

This technical description covers the requirements regarding technical and operational features, as well as testing of the Automatic Voltage Regulator (AVR) device for HV/MV TRANSFORMERS with on-load tap changer (OLTC).

2. OPERATING CONDITIONS

The device must be suitable for operation both indoors and outdoors, with ambient temperature ranging from -10°C to +50°C.

The device may be installed in an area with strong electromagnetic field (Transformers area).

For its proper operation, the device must meet the relevant standards IEC-60255, 61000, 60068 & 60529.

3. OPERATION & ADJUSTMENT FEATURES

3.1 The on-load tap changer mechanism shall be automatically controlled by this device through two (2) contacts, one for increasing and one for decreasing voltage.

3.2 The offered device must be able to control voltages that come from voltage transformer/100 V AC and/110 V AC, 50 Hz and currents of/1 A and /5 A.

3.3 The desired voltage should be set in range of 90-110% of the nominal voltage. The selection of the desired voltage should be continuous or in steps no greater than 0.25%.

3.4 The device must have the ability to dynamically adjust the voltage set-point based on the passing current of the power transformer, with the ability of selecting the type of current dependance (apparent/ active/ reactive), defining positive (for current in the right direction) and negative (for current in the reverse direction) slopes of change of the voltage set-point, defining an upper and lower limit for the voltage set-point, etc. It shall also be able to compensate for the voltage drop in a line with unknown resistive (R) and inductive (X) resistance (Line drop compensation). The selection of individual settings should be continuous or in small steps.

3.5 The device shall be capable of accepting different settings for the right and reverse direction of the active power of the power transformer. It shall also have the option of reverse power blocking or negative active power blocking in the case of reverse active power flow.



- 3.6 The device must provide the ability to control the parallel operation of at least two (2) transformers using the "minimum circulating reactive current method". It must also provide the capability of "Master-Slave" operation. Activating / deactivating these features should be done with simple operations.
- 3.7 The device must provide the ability to adjust the degree of bandwidth between the limits of $\pm 0.5\%$ and $\pm 3\%$ at least. The selection can be continuous or in very small steps (no larger than 0.2%).
- 3.8 The device shall incorporate time delay logic for the execution of the raise or lower command. This delay may be either inverse time or a fixed time of at least 1 to 120 seconds. In the case of fixed time, it must be possible to set two times T1, T2, related to the time of execution of the correction command depending on the amount of voltage deviation.
- 3.9 The device will have a built-in Local/Remote option. The "Local" shall be used to execute manual increase/decrease commands to the OLTC, as well as the command of switching to manual (MANUAL)/automatic (AUTO) control. The above mentioned commands shall be executed by respective push buttons built into the front panel of the device. In "Remote" mode these buttons shall be disabled, and the relevant commands shall be implemented by a higher level of control.
- 3.10 The device shall incorporate logic of stopping its operation (i.e., increase and decrease commands) in at least the following cases:
- a. If the controlled voltage is reduced to 80 to 100% of its nominal value (Undervoltage blocking). The selection must be continuous or in steps of no more than 1%.
 - b. If the controlled voltage raises to 101 to 120% of its nominal value (Overvoltage Blocking). The selection must be continuous or in steps of no more than 1%.
 - c. If the proportional current of the current transformer increases by 50-200% (Overcurrent Blocking). The selection of the desired level should be continuous or in steps of no more than 5%.

Note: The percentage (%) values of the previous paragraphs characteristics, refer to the rated voltage and current values of the secondary of current and voltage transformers of paragraph 3.2.

For all the above cases, it should be possible to select separately for each of them whether to block the increase and/or decrease commands, either in AUTO and/or in MANUAL



- 3.11 The device shall incorporate the logic of fast/sequential increase or decrease commands in case of undervoltage or overvoltage respectively, beyond specific adjustable limits. The adjustment of these limits shall be continuous or in steps of no more than 1%.
- 3.12 The accuracy class of the voltage measuring circuit must be less than 0.3 at a temperature of 20°C and a frequency of 50 Hz $\pm$ 2%.
- 3.13 The power supply voltage of the device shall be 110 V DC, -20%, +20%. In the event of loss and reappearance of the supply voltage, the regulator should be able to restart immediately, without requiring external intervention, having retained all its settings.
- 3.14 The position reader card of the OLTC to be provided with the device shall be two-input card. The first input shall be analog of 0/4-20mA and the second input shall support BCD encoding.
- 3.15 The device shall have a minimum of 8 digital inputs (DI), which shall be freely programmable for controlling and signaling. These DIs shall be independent of those used for the cases where BCD counters are implemented to read the position of the OLTC. The DIs shall be suitable for 110 V DC voltage.
- 3.16 The device must necessarily have the following digital output contacts (DO), suitable for 110 V DC and for the intended function as described below:
 - a. One (1) contact for the voltage increase command (pulse of adjustable duration of at least 1.5 s, with 0.1 s setting step).
 - b. One (1) contact for the voltage reduction command (pulse of adjustable duration of at least 1.5 s, with a setting step of 0.1 s).
 - c. One (1) contact for trip to the thermal switch of the "Motor Drive" of the OLTC.
 - d. One (1) contact to indicate Local/Remote status.
 - e. One (1) contact to indicate AUTO / MANUAL status.
 - f. Contacts for discrete signaling (alarm) of over-voltage, under-voltage, overload, regulator failure, etc.
- 3.17 The device shall have a display for clear visualization of the measurements of the actual values of the voltage and current on the MV side of the power transformer, as well as the tap position of the OLTC of the transformer. The device shall also have function keys/buttons for menu navigation and buttons for control (LOCAL/REMOTE control, AUTO/MANUAL control, tap increase/decrease command), and at least eight (8) "LED" lights for signaling and indicating, with at least half of them being programmable.



4. COMMUNICATION

4.1. It shall incorporate the ability to transmit all indications, signals and measurements of analogue quantities to the above level of supervision and control of the substation, as well as to receive commands from it, via IEC-61850 protocol. The AVR shall support the IEC 61850 protocol, it shall have two optical Ethernet ports (100BASEFx) and shall support the IEC 62439-3 PRP standard for its interface with the substation supervisory and control system data network.

4.2. The device must also support SNTP protocol for time synchronization.

4.3. Programming/configuration of the AVR will be performed both from the built-in display and keyboard, and via the local network, as well as by connecting to a portable PC via a suitable communication port. The communication port of the AVR is desirable to be of Ethernet or USB type. If it is proven that no version of the AVR with Ethernet or USB port is available, then delivery of the device accompanied by a suitable communication cable-converter to Ethernet or USB (laptop) port will be accepted. In this case, the supplier shall be obliged to deliver one converter cable per device.

4.4. Any software required to program/configure the device from a laptop should be provided. At least three (3) user licenses shall be provided.

4.5. At least three (3) communication cables between the device and the portable computer will be delivered.

5. SHELL

The device will be contained in a watertight shell and shall be supported in such a way as to exclude its operation (increase or decrease command) due to vibrations or electromagnetic fields. The main parts of the device should be accessible by removing the cover, for easy installation of the various settings without interrupting the operation of the device.

6. TESTS

Type and routine tests shall include as a minimum accuracy, insulation, and durability tests in accordance with IEC 60255, 61000, 60068 & 60529 standards. The test certificates shall be of an accredited laboratory (international or national).

7. DATA WHICH MUST BE SUBMITTED WITH THE OFFER



Technical Documents in Greek or English must necessarily accompany the offer. These brochures must contain the full technical characteristics of the apparatus and a detailed description of its operation and capabilities, its wiring diagrams, dimensions and all the information necessary for the technical evaluation of the tenders based on this technical description.

Type test certificates in accordance with paragraph 6 shall also be provided.

8. DATA WHICH MUST BE SUBMITTED WITH THE DELIVERY OF THE DEVICES

Upon delivery of the devices, the supplier must submit technical brochures and forms in printed and electronic form with detailed instructions for configuration, operation, maintenance, repairs and troubleshooting of anomalies of the devices, type and series test certificates, internal wiring diagrams, etc.

9. WARRANTY

The warranty period will have a duration of at least two (2) years and will start from the date of delivery of the material to the company's warehouse. During the warranty period, the supplier shall, at no additional charge, replace any component and/or the entire device that is found to be malfunctioning or damaged after it is placed in normal operation.