GUIDEFORM SPECIFICATION

Generator Protection and Control REG630

Numerical generator protection in medium voltage networks

The freely configurable relay is intended for protection, control, measurement and supervision of small and medium-sized generators and generator transformer units in diesel, gas, hydroelectric, combined heat and power (CHP), and steam power plants.

Mechanical and construction details

- The relay shall have compact dimensions not exceeding 4U in height for panel door mounting installations.
- The relay shall support flush, semi-flush, rack and wall mounting options.
- As flush mounted, the relay shall meet the IP40 (with detached HMI IP42) ingress protection requirements on the front side and IP20 on the rear side and connection terminals.
- To facilitate quick replacement, the relay shall have detachable connectors with secure current transformer (CT) shorting. It shall be possible to quickly replace the faulty unit with a spare without disturbing any of the wiring.
- The relay shall have an integrated human-machine interface (HMI) or alternatively be offered with a detached HMI. The detached HMI shall enable flexible installation for reduced wiring and weight impact on the panel door of the low voltage (LV) compartment.
- The power supply to the detached HMI shall be provided using Power over Ethernet (PoE) to avoid additional wiring for the auxiliary voltage.
- The HMI of the relay shall have a large graphical display with dimensions no less than 70 mm x 100 mm and 320 x 240 pixel resolution, allowing the display of at least 10 switching objects. The HMI shall also include 5 freely configurable push buttons.

Protection and control functions

- The relay shall have comprehensive machine/generator differential protection, including both three-phase differential protection (87G/M) with one low-set (biased) and one high-set (instantaneous) stage for generator winding protection and high-impedance or flux-balance based differential protection (87GH/MH) providing winding short-circuit protection for generators.
- The stabilized differential protection shall have a DC restraint feature for temporarily decreasing the sensitivity of the differential protection. The feature shall avoid unnecessary disconnection of the generator due to spurious differential current, caused by uneven CT saturation resulting from long lasting DC components.
- For generator-transformer block applications, the relay shall have differential protection (87T) with numerical transformer vector group compensation and two independently settable stages. The stabilized (biased) low-set stage shall provide fast fault clearance while remaining stable when high currents are passing through the protected zone, which increases current measurement errors. The instantaneous high-set stage shall provide very fast clearance of severe in-zone faults with a high differential current regardless of their harmonics content. The operate time of the instantaneous stage shall be less than 20 ms.
- The relay shall have non-directional overcurrent (50/51) and earth-fault (50/51N) protection with multiple stages with settable definite time (DT) and inverse definite minimum time (IDMT) characteristics, supporting both IEC and ANSI/IEEE operating curves.

- The relay shall have two-stage voltage-dependent overcurrent protection (51V) protecting generators agaist short circuit faults occurring close to the generator terminals. The function shall include settable definite time (DT) and inverse definite minimum time (IDMT) characteristics.
- The function shall operate when the current exceeds a set value dynamically calculated based on the measured terminal voltage. It shall also be possible to select either a voltage restrained/ voltage slope or voltage controlled/voltage step characteristic.
- The relay shall have three-stage directional overcurrent protection (67) with voltage memory and positive and negative-sequence voltage polarization.
- The relay shall have three-stage directional earth-fault protection (67N) with selectable negative and zero-sequence voltage polarization. I_0 and U_0 shall be derived either from the phase voltages and currents or from the measured neutral current and residual voltage.
- The relay shall have high-impedance (87NH) restricted earth-fault protection.
- For protection of generator-transformer blocks the relay shall have two-stage underimpedance protection (21GT) as backup protection against short circuits at the generator terminals or for faults on the HV-side of a transformer. Underimpedance protection shall be applied instead of definite time voltage-dependent overcurrent protection to obtain a limited protection zone and an optimum operating time. The relay shall have two-stage negative-sequence overcurrent protection (46G/46M) against single-phasing, unbalanced load or unsymmetrical voltage, with DT or IDMT charecterisitcs and settable between 0.01 and 5 times pu. The negative-sequence overcurrent protection must be blocked if the current circuit supervision detects a fault in the current measuring circuit.
- The relay shall have three-phase thermal overload protection (49T/G) and protect the transformer/ generator mainly from short-time overloads. The protection shall be able to utilize either one or two time constants, which shall be selectable. It shall be possible to include the ambient temperature measured from an external temperature sensor in thermal modeling for better accuracy.
- The relay shall have comprehensive voltage protection functionality, including at least overvoltage(59), undervoltage(27), positive-sequence overvoltage(47O+), positive-sequence undervoltage(47U+), negative-sequence overvoltage(47O-) and residual overvoltage (59G) protection.
- The relay shall have four-stage frequency protection(81), including at least overfrequency, underfrequency and frequency rate-of-change protection with rate-of-rise or rate-of-fall freely selectable for each stage.
- For complete (100%) stator earth-fault protection, the relay shall have third harmonic-based stator earth-fault protection (27/59THD) in addition to fundamental frequency-based residual overvoltage protection. The third harmonic-based protection shall offer the following alternative protection methods :
  - Differential of the third harmonic component measured both at the generator neutral and terminal side
  - Neutral side third harmonic undervoltage
- To protect the generator and turbine from the harmful effect of excessive power/motoring, the relay shall have reverse power/directional overpower protection (32R/32O).
- The relay shall have two-stage underpower protection (32U) for protecting the generator and prime mover against the effects of very low power output or reverse power conditions.
- It shall be possible to use positive-sequence components for calculating power, which makes the determination of power insensitive to the possible asymmetry in currents or voltages and corresponds to the real load of the generator's prime mover.
- The relay shall have overexcitation (V/Hz) protection (24) to protect generators and transformers against an excessive flux density and saturation of the magnetic core. The function shall include settable definite time (DT) and inverse definite minimum time (IDMT) characteristics, and a settable alarm.

- The relay shall have two-stage underexcitation protection to protect synchronous machines against underexcitation or loss of field/excitation conditions, which may cause excessive heating in the end region of the stator winding, damaging the insulation of the stator winding and the iron core. The function shall prevent the machine from operating in the asynchronous mode to avoid increased rotor speed, which causes heating in the rotor iron. The protection shall be based on the offset-mho circle characteristic on the impedance plane, defined by setting the Offset, Diameter and Displacement values. For impedance calculation, the voltage selection options shall be 1Phase-earth, 1Phase-phase, 3Phase-earth, 3Phase-phase and Pos Seqn.
- To monitor the insulation level of the rotor and associated brushes, the relay shall have an injection-based rotor earth-fault protection (64R) with alarm and operate stages. The alarm and operate stages shall be settable between 1…10 kΩ to correspond to the rotor earth-fault resistance value. An injection device shall optionally be provided by the relay manufacturer. To eliminate the 3rd and 6th harmonics as prevalent in the excitation current, the protection algorithm shall use DFT (discrete fourier transform) value calculation to filter DC and other harmonic components that could otherwise generate false alarms or trip signals.
- The relay shall have circuit breaker failure protection (51BF/51NBF) including independent timers for repeated tripping of the same breaker and backup tripping of the upstream breaker. The function shall allow higher selectivity by avoiding tripping of the upstream breaker if the repeated tripping of the breaker closest to the fault is successful.

Distributed Power Generation Units (DPGU) :

- In distributed power generation applications where the power generation units (PGU) are connected to the grid, the PGUs are required to comply with grid connection requirements (grid codes) including system stability, reactive power support, transient recovery and voltage-frequency regulations. The grid codes require the distributed PGUs to remain connected even during network disturbances to ensure grid stability and reliability and thus avoiding a grid collapse. To enable the connection of distributed power generation units to the grid the relay shall include the following protection functions:

- The relay shall have low-voltage ride-through protection (27RT) with a user-definable Low-Voltage-Ride-Through (LVRT) curve for generators to comply with local or national grid code requirements. The LVRT curve shall have at least 10 time-voltage coordinates for accurate definition of the curve. The protection function shall for LVRT curve monitoring include the following voltage selection options for detecting undervoltage: highest Ph-to-E, lowest Ph-to-E, highest Ph-to-Ph, lowest Ph-to-Ph and Positive Sequence.
  To ensure power system stability, the relay shall have directional reactive power and undervoltage protection (32Q,27) and monitor the reactive power flow to prevent a power system voltage collapse in the event of a network fault. The function shall include two independently settable stages enabling the disconnection of the generator circuit breaker, or the common coupling breaker if several power generating units are operated in parallel and feeding the network.
- To protect synchronous generators from damage due to islanding or loss-of-mains conditions, the relay shall have vector shift protection (78V). The function shall continuously measure the voltage cycle shift in terms of phase angle, which shall be settable between 2…30 degrees with 1 degree resolution. The voltage phase supervision shall be based on the positive sequence voltage.
- The relay shall support the combined and parallel use of multiple protection functions to detect loss-of-mains conditions. The relay shall to minimize the non-detectable zone support the combination of vector shift protection (78V) and frequency rate-of-change protection (81R), or other user-definable combinations of passive detecting techniques such as overvoltage, undervoltage, overfrequency, underfrequency, rate-of-change of frequency and voltage unbalance.

Inputs and outputs

- The relay shall have a scalable amount of binary inputs and outputs. The number of binary inputs shall be scalable up to 50 and the number of binary outputs to 45.
- The relay shall have at least 3 trip output relays with integrated trip circuit supervision (TCS). The trip output relays shall be rated to make and carry 30 A for 0.5 s.
- The threshold voltage of the relay's binary inputs shall be independently settable between 15...221 V DC.
- The binary inputs of the relay shall, when energized, utilize a higher inrush current to facilitate the breaking of possible dirt or sulfide from the surface of the activating contact.
- The relay shall optionally include 8 resistance temperature detector (RTD) sensor/analog inputs for measuring stator winding, bearing and ambient temperatures of a three-phase machine. Each input shall be freely configurable for a specific type of input signal, either RTD, mA, voltage or resistance, and the selection software based.
- The RTD inputs shall support both 2-wire and 3-wire measurements for RTD and resistance modes.
- The relay shall support the commonly used sensor types Pt100, Pt250 ,Ni100, Ni120, Ni250 and Cu10 with 2-wire or 3-wire connection with common ground.
- The relay shall have 4 mA outputs settable between -20 mA and +20 mA. Each output shall be separately configurable, scalable and blocked.
- The phase current inputs and and the residual current input of the relay shall be rated 1/5 A. The selection of 1 A or 5 A shall be software-based.
- For applications requiring sensitive earth fault protection the relay shall offer an optional 0.1/0.5 A residual current input. The selection of 0.1 A or 0.5 A shall be software-based.

Measurements, alarms and reporting

- The relay shall have three-phase current, residual current and voltage measurement with an accuracy of ±0.5%, and positive and negative sequence current and voltage measurement with an accuracy of ±1%.
- The relay shall support current and voltage phase-angle measurement viewing via the local HMI.
- To collect sequence-of-events (SoE) information, the relay must incorporate a non-volatile memory with a capacity of storing at least 1000 event codes with associated time stamps and user-definable event texts with a minimum resolution of 1 ms.
- The relay shall include a numerical disturbance report containing information on the fault. The report shall incorporate the recording time, prefault and postfault time, prefault amplitude, prefault angle, fault amplitude and fault angle trip values. The report shall be stored in a non-volatile memory and be accessable via the local HMI.
- The relay shall have a disturbance recorder supporting a sampling frequency of 20 samples per cycle and featuring up to 40 analog and 64 binary signal channels.
- The relay shall support not less than 100 recordings with a sampling frequency of 20 samples per cycle, each recording 3.4 seconds in length, 10 analog channels and 64 binary channels.
- The relay shall have a runtime counter for machines and devices. The function shall count either the long-term accumulated operating time or the short-term single run duration.

Communication

- The relay must support IEC 61850 Edition 1.
- The relay must support, besides IEC 61850, simultaneous communication using one of the following communication protocols: IEC 60870-5-103 or DNP3 (TCP).
- The relay shall have an Ethernet port with a galvanic (RJ45) or an optical (LC) interface.
- The relay must have an Ethernet port (RJ45) on the front for local parametrization and data retrieval.
- The relay shall support up to five IEC 61850 (MMS) clients simultaneously.
- The relay must support IEC 61850 GOOSE messaging and meet the performance requirements for tripping applications (<10ms) as defined by the IEC 61850 standard.
- The relay shall support sharing analog values, such as temperature, resistance and tap positions using IEC 61850 GOOSE messaging.
- The relay must support the SNTP (Simple Network Time Protocol) and IRIG-B (Inter-Range Instrumentation Group - Time Code Format B) time synchronization methods.

Engineering and configurability

- The relay must have 4 independent settings groups for the relevant protection settings (start value and operate time). It must be possible to change protection setting values from one setting group values to another via the local HMI, using a binary input signal, and remotely through the communication link.
- The relay must have a web browser-based human-machine interface (WHMI) that shall provide access to:
  - Sequence-of-events (SoE)
  - Device status
  - Parameter settings
  - Measurements
  - Disturbance records
  - Phasor diagram
  - Programmable LED status
- The relay HMI and configuration tool shall have multilingual support.
- The relay HMI and configuration tool shall support both IEC and ANSI protection function codes.
- The relay shall have at least 15 freely configurable programmable three-color LEDs.
- The relay must have at least 4 user-configurable local HMI pages including measurements and single line diagram (SLD).
- The relay shall have a graphical configuration tool for the complete relay application including multi-level logic programming support, timers and flip-flops.
- The relay configuration tool must include online visualization of the relay application state.
- It must be possible to keep the relay configuration tool up-to-date using an online update functionality.
- The relay configuration tool shall support viewing of relay events, disturbance reports and visualization of disturbance recordings.
- The relay configuration tool must include the complete relay documentation including operation and technical details.
- The relay configuration tool must include functionality for comparing the archived configuration to the configuration in the relay.
- The relay configuration tool must allow configuration of IEC 61850 vertical and horizontal communication including GOOSE.
- The relay configuration tool must support importing and exporting of valid IEC 61850 files (ICD, CID, SCD, IID).
- The relay configuration tool must be compatible with earlier relay versions.
- It shall be possible to freely assign current and voltage inputs to protection and measurement functions.

Type tests and other compliance requirements

- The relay shall have a continuous operational temperature range of -25 … +55°C and transport and storage temperature range of -40...+85°C.
- The relay must fulfill mechanical tests IEC 60255-21-1, -2 and -3 according to Class 1 for vibrations, shock, bump and seismic compliance.
- The relay must fulfill the electromagnetic compatibility (EMC) tests according to IEC 60255-26.
- The relay must be tested according to the requirements of the IEC or an equivalent standard.

Additional information

For more information, please contact your local ABB representative or visit our website at:
www.abb.com/substationautomation
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