

Motor Protection and Control REM620

Numerical motor protection in medium voltage networks

The configurable motor management relay is intended for protection, control, measurement and supervision of medium-sized and large asynchronous and synchronous motors requiring differential protection, in low and medium voltage networks in the process and manufacturing industry and utility power plants.

Mechanical and construction details

- The relay shall have compact dimensions not exceeding 4U in height. The depth of the relay shall, without any additional raising frame, not exceed 160 mm when flush mounted so as not to foul with other equipment mounted inside the cabinet. The weight of the relay must not exceed 6 kgs to permit use of optimized sheet metal thickness in construction of panels.
- The relay shall support flush, semi-flush, rack and wall mounting options.
- As flush mounted, the relay shall meet the IP54 ingress protection requirements on the front side and IP20 on the rear side and connection terminals.
- To facilitate quick unit replacement, the relay design shall be of draw-out type with secure current transformer (CT) shorting. It shall be possible to quickly replace a faulty unit with a spare without disturbing the majority of the wiring. The mean time to repair (MTTR) shall be less than 30 minutes.
- To prevent unauthorized detachment of the relay plug-in unit, the relay shall be provided with an integrated seal.
- The relay shall have a graphical display with at least 7 rows of characters and up to 20 characters per row.
- The HMI shall include at least 16 freely configurable push buttons with integrated status LEDs.

Protection functions

- The relay shall have non-directional phase overcurrent and earth-fault protection (50/51) with multiple stages, definite time (DT) and inverse definite minimum time (IDMT) characteristics, and IEC and ANSI/IEEE operating curves.
- The relay must have three-stage directional phase overcurrent protection (67) with voltage memory and positive and negative-sequence polarization.
- The relay must have two-stage directional earth-fault protection (67N) with selectable negative and zero-sequence 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 comprehensive differential protection including stabilized differential protection (87M/G), high-impedance and flux-balance based differential protection (87MH) to provide stator winding short-circuit and earth-fault protection.
- The relay shall have voltage protection including at least over- and undervoltage, positive-sequence undervoltage, negative-sequence overvoltage and residual overvoltage protection.
- The relay shall have arc protection based on simultaneous detection of current and light. During maintenance work at the substation, it shall be possible to change the operation criteria to light only via a binary input.

Startup and start control

- The relay shall include motor start-up supervision. The function shall offer protection in case of an excessive start-up time of the motor.
- The start-up supervision shall be based on monitoring the true RMS value of all the phase currents or by monitoring the status of the circuit breaker connected to the motor.
- The relay shall include support for connecting a speed switch indicating whether the rotor is rotating or not.
- The phase reversal protection (46R) of the relay must be based on the calculated negative phase-sequence (NPS) current. During motor startup the relay shall, by monitoring the NPS current values, detect incorrectly connected phases and inhibit the motor from rotating in the opposite direction.
- The relay shall include motor load jam protection i.e. locked rotor protection (51LR) for a running motor. The motor load jam protection function shall be blocked by the motor start-up supervision function.
- The relay shall include loss of load supervision (37), as loss of load is considered a fault condition. The function shall operate when the current drops below the set start value. The relay shall differentiate between loss of load and standstill situations.
- The relay shall include an emergency start function, which shall allow motor start-up during emergency conditions. The function shall force the relay to allow motor restart. After the emergency start input has been activated, it shall be possible to start the motor normally.

Thermal protection

- The relay shall include motor thermal overload protection (49) to protect the electric motor from overheating. To meet critical operational requirements, it must be possible to block the function.
- The motor thermal overload protection shall consider both the true RMS and negative-sequence currents. In case of unbalanced phase currents, the negative-sequence current must be considered since it causes additional heating. For accurate calculation of the different motor thermal conditions, the relay shall have three time constants for the running conditions of the motor, i.e. start-up, normal run and power-off.
- The relay shall include two stages of negative-sequence overcurrent protection 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, or if the relay detects a reverse network rotating direction via a binary input signal from an external device.

Synchronous machines

- The relay shall include functionality for detecting underexcitation (40) and loss of 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, which increases the rotor speed, causing heating in the rotor iron and damper windings.
- The relay shall have directional overpower protection (32O) to detect whether the motor consumes reactive power due to the loss of excitation field. It shall be possible to select the operating direction with the combination of the settings directional mode and power angle, where directional mode can be either forward or reverse and power angle set between reactive or active power. The power setting shall settable between 1...200 % of the machine's apparent power in steps of 1% and the operate time to 0,04...300 seconds.

- The relay shall include two stage under power protection (32U) to detect loss of load condition, which is considered a fault condition. The function shall calculate apparent power based on the selected voltage and current measurements. It shall be possible to use positive-sequence components for calculating apparent power, which makes the determination of power insensitive to the possible asymmetry in currents or voltages.
- 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 k Ω 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 back-up 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.
- The relay shall have six-stage frequency (81) protection. The frequency shall be measured using the positive-sequence voltage. It shall be possible to set each stage individually to operate based on underfrequency, overfrequency or rate-of-change of frequency.
- To determine whether and when to disconnect a distributed generation unit from the grid during network disturbances, the relay shall have three-stage low-voltage ride-through protection (27RT) with a user-definable Low-Voltage Ride-Through (LVRT) curve, to comply with local or national grid code requirements.
- 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.
- 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.

Other functions

- The relay shall support local and remote control of circuit breakers and motor operated disconnectors/earthing switches. The relay shall provide status indication for manually operated disconnectors/earthing switches.
- The relay shall include a synchro-check (25) function for circuit breaker closing. The function shall ensure that the voltage, phase angle and frequency on either side of an open circuit breaker meet the requirements for safe interconnection of two networks. The function shall include energizing check functionality and support the operation modes dead-line/live-line and dead-bus/live-bus. To enable circuit breaker closing when reconnecting two asynchronous networks, the function shall consider the circuit breaker closing delay and the measured slip frequency to ensure that the closing command is given at the right moment. The function shall include phase-shift compensation for cases where the reference voltage is measured across a power transformer.

Inputs and outputs

- The relay shall have at least 20 binary inputs and 14 binary outputs and all of them freely configurable. Optionally, it must be possible to add another 8 binary inputs and 4 binary outputs.
- To enable direct tripping of the circuit breaker, the relay must have 2 double-pole power output relays with integrated trip-circuit supervision (TCS). The two power output relays shall be rated to make and carry 30 A for 0.5 s with a breaking capacity of ≥ 1 A (L/R < 40 ms).
- To enable fast direct tripping of the circuit breaker, the relay must have 3 optional high-speed binary outputs with an operate time of ≤ 1 ms. The binary output contacts shall be rated to make and carry 30 A for 0.5 s with a breaking capacity of ≥ 1 A (L/R < 40 ms).
- The threshold voltage of the relay's binary inputs shall be settable to 16...176 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 offer 12 optional RTD inputs and 4 mA inputs for measuring stator winding, bearing and ambient temperatures.
- The phase current inputs 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 0.2/1 A residual current input. The selection of 0.2 A or 1 A shall be software-based.
- The relay must offer optional current and voltage sensor inputs and support the use of combined current and voltage sensors connected with one connector per phase. The current sensor inputs must facilitate the usage of sensors within the nominal range of 40...4000 A without any external adaptors.

Measurements, alarms and reporting

- The relay shall provide comprehensive measurement of three-phase currents and voltages (fundamental or RMS-based as selectable options) with an accuracy of $\pm 0.5\%$ and zero, negative and positive-sequence current and voltage measurement with an accuracy of $\pm 1\%$ within the range of ± 2 Hz of the nominal frequency. Power measurement (P, Q & S) shall be provided with in the accuracy of $\pm 1.5\%$ and Power Factor measurement shall have an accuracy of ± 0.015 .
- To collect sequence-of-events (SoE) information, the relay must include a non-volatile memory with a capacity of storing at least 1024 event codes with associated time stamps.
- The relay must support the storage of at least 128 fault records in the relay's non-volatile memory.
- The fault record values must at least include phase currents, phase voltages, zero, negative and positive-sequence currents and voltages, and the active setting group.
- The relay shall have a disturbance recorder supporting a sampling frequency of 32 samples per cycle and featuring up to 12 analog and 64 binary signal channels.
- The relay's disturbance recorder shall support not less than 6 three-second recordings at 32 samples per cycle for 12 analog channels and 64 binary channels.
- The relays shall support up to 100 disturbance recordings.
- The relay must have a load profile recorder for phase currents and voltages supporting up to 12 selectable load quantities and more than 1 year of recording length. The load profile recorder output shall be in COMTRADE format.

Communication

- The relay must support IEC 61850 Edition 1 and Edition 2.
- The relay must support, besides IEC 61850, simultaneous communication using one of the following communication protocols: Modbus® (RTU-ASCII/TCP), IEC 60870-5-103 or DNP3 (serial/TCP). With external adapter it shall support Profibus where needed.
- 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.
- For redundant Ethernet communication, the relay shall offer either two optical or two galvanic Ethernet network interfaces with HSR and PRP-1.
- The relay shall have a third Ethernet port for providing connectivity of any other Ethernet device to an IEC 61850 station bus inside a switchgear bay.
- 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 IEEE 1588 v2 for high-accuracy time synchronization (< 4 μ s) in Ethernet-based applications. The relay shall also support the SNTP (Simple Network Time Protocol) and IRIG-B (Inter-Range Instrumentation Group - Time Code Format B) time synchronization methods.
- The relay must support IEC 61850-9-2LE process bus for sending sampled values of currents and voltages.

Engineering and configurability

- The relay must have 6 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 to another in less than 20 ms from the binary input activation.
- The relay must have a web browser-based human-machine interface (WHMI) with secured communication (TLS) and shall provide the following functions:
 - Programmable LEDs and event lists
 - System supervision
 - Parameter settings
 - Measurement display
 - Disturbance records
 - Phasor diagram
 - Single-line diagram (SLD)
 - Importing and exporting of parameters, sequence-of-event (SoE) information and disturbance records
- When a protection function is disabled or removed from the configuration, neither the relay nor the configuration tool shall show the function-related settings.
- 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 11 freely configurable and programmable two-color LEDs.
- The relay must have at least 10 user-configurable local HMI views including measurements and SLDs.
- 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, fault records 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 and sampled values.
- 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.

Type tests and other compliance requirements

- The relay shall have continuous operating temperature range of -25 ... +55 °C and transport/storage temperature range of -40...+85 °C.
- The relay must fulfill the mechanical test requirements according to IEC 60255-21-1, -2 and -3, Class 2 for vibration, shock, bump and seismic compliance.
- The relay's maximum DC auxiliary power consumption shall be less than 20 W (all inputs activated and over the full supply range).
- The relay must have an IEC 61850 Edition 1 certificate from an accredited Level A testing laboratory.
- The relay must have an IEC 61850 Edition 2 certificate from an accredited Level A testing laboratory.
- The relay must fulfill the electromagnetic compatibility (EMC) test requirements according to IEC 60255-26.
- The relay must be tested according to the requirements of the IEC or an equivalent standard.
- The relay must be certified by independent test laboratories for marine applications.

Additional information

For more information, please contact your local ABB representative or visit our website at:

www.abb.com/substationautomation

www.abb.com/mediumvoltage