PS - 002

Synchronous Generator Protection Module

Overview

In the design of electrical power systems, the ANSI Standard Device Numbers ANSI/IEEE Standard denote what features a protective device supports such as a relay or circuit breaker. These types of devices protect electrical systems and components from damage when an unwanted event occurs, such as an electrical fault. Device numbers are used to identify the functions of devices. This module introduces the difference between power supplies and power generation and how the power generation is performed.



Specifications

- Phase under-voltage protection (ANSI Standard: 27P)
- Loss of prime-mover protection (ANSI Standard: 32R)
- Directional reactive overpower protection (ANSI Standard: 40/O)
- Stator thermal overload protection with inverse time characteristic (ANSI Standard: 49S)
- Non-directional instantaneous and overcurrent protection (ANSI Standard: 50P/51P)
- Earth fault instantaneous and overcurrent protection (ANSI Standard: 50N/51N)
- Over-frequency protection (ANSI Standard: 81O)
- Generator differential protection (ANSI Standard: 87G)

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Technical Data

Phase under-voltage protection relay (ANSI Standard: 27P)

- Continuously monitors the three-phase output voltage of synchronous generator to warn against under-voltage condition during synchronization process
- If measured voltage moves below the set point limit, the relay contacts will change-over after the selected "Delay-OFF" has elapsed, giving an alarm or initiation signal.
- If voltage measured exceeds threshold (set point), the relay contacts will return to original state only after the reset time ("Delay-ON") has elapsed.
- Can be used in 3-wire and 4-wire network
- Offers user adjustable trip point (set point) and time delay settings.
- The set point adjustment for under-voltage is in the range of 25%
- As soon as the monitored signal moves outside of the set point limit, the time delay is activated, after which a trip will occur. The time delay prevents the relay from tripping for a predetermined period to prevent nuisance tripping.
- The relay is automatically reset once the monitored voltage rises above the set point.
- Adjustable off-delay: 0.1 …20sec
- Adjustable reset-delay: 0.1…20sec
- Adjustable under-voltage trigger range: 70% …95% (corresponding to 270V…370V AC)
- LED indicators for relay activation during under-voltage condition
- Relay output: Single change-over contact
- Contact rating: 250V AC, 8A

Loss of prime-mover protection relay (ANSI Standard: 32R)

- The protective reverse power relay will prevent a generator running in parallel with other generators from running as a motor («motoring») in case of lost prime mover torque, and will thus protect the prime mover.
- Ensure that the remaining generators connected to the system are not overloaded.
- Protects against reverse power due to an increase of the power of other generators connected to the system.
- The applied TDM (Time-Division-Multiplication) principle ensures an accurate measurement of the RMS value of the power (U × I × cos-φ), irrespective of wave form.
- Works with 3-wire and 4-wire connection.
- LED indication of fault condition
- Timer controlled tripping
- LED indication for activated relay
- Reverse power set point: (0…25%) of rated active power of synchronous generator
- Tripping time delay: 0…20sec
- Relay contact: Single change-over switch
- Contact ratings: 250V-8A (AC)

Directional reactive overpower protection relay (ANSI Standard: 40/O)

- Prevents the generator against damages caused by excessive heating due to slip frequency current flow.
- Prevent transfer of reactive load from the grid/ other alternators in parallel to a faulty generator.
- Protects against "loss of excitation", as well as "over-excitation"
- The applied TDM (Time-Division-Multiplication) principle ensures an accurate measurement of the RMS value of the reactive power (U × I × sin-φ), irrespective of wave form.
- Works with 3-wire and 4-wire connection.
- If the reactive power exceeds the set point, the output is activated. The set point value is set on the front of the relay by means of a potentiometer. If the reactive power exceeds this, a fault signal is generated, and the associated yellow LED is lit.
- Reactive power set point in case of under-excitation: (0…25%) of rated reactive power

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- » Reactive power set point in case of over-excitation: (25…125%) of rated reactive power
- » Tripping time delay: 0…20sec
- » Relay contact: Single change-over switch
- » Contact ratings: 250V-8A AC

Stator thermal overload protection relay with inverse time characteristic (ANSI Standard: 49S)

- » Differential thermal overload relay
- » Phase failure sensitive
- » Reset mode can either be manual or automatic.
- » Pushbutton for simulating relay tripping
- » Pushbutton for "Stop" and manual Reset
- » Trip flag indicating overload relay tripped.
- » Rated operational voltage: 0…400V AC
- » Thermal protection adjustment range: 1.6A…2.5A AC
- » Phase failure sensitivity tripping current: 130 % of "In" on two phases, the last phase at 0 current or 30 % of "In" on one phase, the others at "In".
- » Auxiliary contact: 1 NO + 1 NC
- » Tripping threshold: (1.14 +/- 0.06) x In

Non-directional instantaneous and overcurrent protection relay (ANSI Standard: 50P/51P)

- » This combined short circuit and over-current relay is applied for protection of generators against both over-currents and short circuit currents (I> and I>>).
- » The relay measures the highest of the 3-phase currents, providing an RMS measurement at sinusoidal currents.
- » The measurement is based on average values for I>, peak values for I>>
- » The set point values are set on the front of the relays by means of potentiometers.
- » If a current exceeds a set point, the output is activated.
- » If exceeded, a fault signal is generated, and the associated yellow LED is lit.
- » Measurement of 3-phase currents
- » LED indication of fault condition
- » Timer-controlled tripping
- » LED indication for activated relay
- » When the set point is exceeded, its timer starts and will run as long as the fault condition prevails.
- » If the fault disappears, the timer is reset. When the timer expires, the contact is activated and the associated red LED is lit.
- » Short circuit current setting: 1.0 to 4.0 × In
- » Tripping delay time for short-circuit current: 0 to 1sec
- » Over-current setting: 0.5 to 1.5 × In
- » Tripping delay time for over-current: 0 to 20sec
- » Number of contacts: Single change-over switch per relay type
- » Contact ratings: 250 V AC/24 V DC, 8 A (200,000 change-overs at resistive load)

Earth fault instantaneous and overcurrent protection relay (ANSI Standard: 50N/51N)

- » Stator earth fault relay protects genset operators against electric shock in case of earth faults in the generator's stator.
- » The relay also protects against loss of excitation in case of earth fault in the stator.
- » Protects the voltage source and load networks against earth fault in a solid-earth, or a low-resistance TN system.
- » The relay measures the leakage or a short circuit from one or more of the phases to earth.
- » In order to obtain a short response time on a fault condition, the measurement is based on peak values.
- » The earth fault current protection is obtained by connecting an external current transformer in the star point of the protected voltage source.
- » In order to prevent malfunction due to 3rd harmonic, the relay is equipped with a special filter cutting off frequencies higher than 50/60 Hz.
- » The set point values for ground currents are set on the front of the relay by means of potentiometers.
- » If exceeded, a fault signal is generated, and the associated yellow LED is lit.
- » The relay is provided with two outputs with contacts either normally energized

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or normally de-energized based on the supplied auxiliary power.

- Earth fault protection at two levels (instantaneous and definite-time ground-fault protection)
- Built-in filter for 3rd harmonic
- LED indication of fault condition
- Timer-controlled tripping
- LED indication for activated relay
- Earth leakage current setting: 2…20% of In
- Tripping delay time for leakage current: 0 to 20sec
- Earth short-circuit current setting:10...100% of In
- Tripping delay time for short-circuit current: 0 to 1sec
- Relay contact: 1 change-over switch per relay type
- Contact voltage rating: Max. 250V AC, 8A

Over-frequency protection relay (ANSI Standard: 81O)

- Frequency protectors offer user adjustable frequency trip point (set point)
- The set point adjustment range is centered around the nominal 50Hz or 60Hz system frequency.
- If the measured frequency moves outside the set point limit, the relay will operate, giving an alarm or initiation signal.
- The unit draws their operating power from the measuring inputs. No separate power supply is required
- When the monitored frequency exceeds the set point, the relay will energize and the LED indicator will illuminate to indicate the trip condition.
- The tripping action can be delayed through an adjustable delay knob
- The relay will automatically reset once the monitored frequency falls below the set point
- When monitoring relay is reset, the LED will extinguish and the relay contacts de-energizes.
- Operating (monitored) voltage: 220-240V AC
- Adjustable Power-on delay range: 1…10sec
- Adjustable tripping delay range: 1…10sec
- Relay output: Single change-over contact
- Contact rating: 250V AC, 8A

Generator differential protection relay (ANSI Standard: 87G)

- Protects the synchronous generator against leakage currents in the windings of the generator.
- The relay compares the differential current of each of the three phases, providing an RMS measurement at sinusoidal currents.
- The differential currents are obtained by connecting the external current transformers for each winding in parallel with inverse polarity.
- The measurement is not stabilized, implying that the relay contact is activated for disconnection of the supervised unit when the differential current of the individual phases exceeds its set point, irrespective of the amperage of these.
- The three differential currents are measured by the relay and the highest of these is selected. If this exceeds the set point, the output is activated.
- The set point value is set on the front of the relay by means of a potentiometer. If exceeded, a fault LED illuminates, however, contacts are not yet energized.
- When the set point is exceeded, if delay is set, its timer starts and will run as long as the fault condition prevails. If the fault disappears, the timer is reset.
- When the timer expires, the contact is activated and the associated relay LED indicator is lit.
- Differential current setting: 0.04 to 0.4 × In
- Tripping delay setting: 0 to 1sec
- Maximum input current: 4x In
- Relay output: 2x change-over contacts
- Contact rating: 250V AC, 8A

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Experiments

- Stator Differential Protection of a Synchronous Generator
- Loss of prime mover Protection of a Synchronous Generator
- Reactive power reverse flow Protection of a Synchronous Generator
- Synchronous generator over-excitation protection
- Over-frequency Protection of a Synchronous Generator
- Protection against earth leakage fault of a Synchronous Generator

Scope of Delivery

- Synchronous Generator Protection Module (PS - 002)

Options

- Digital content (BI-01)

Required for Operation

- Generation Module (PS - 001.2)

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